Sports related concussion
Management in general practice

Background
Concussive injuries are common in many sports and recreational activities, especially those involving body contact, collisions or high speed. Over the past 8 years, international experts met on three occasions to address key issues in the understanding and management of concussion in sport; most recently in Zurich in November 2008. The consensus statement produced from this meeting provides an outline of up-to-date knowledge and best practice management guidelines on concussion in sport.

Objective
The aim of this article is to provide an overview of the key concepts from the Zurich consensus statement, including an understanding of concussion and an outline of potential risks and recommended management as applicable to the general practice setting.

Discussion
Concussion is thought to reflect a functional injury to the brain. Clinical features are typically short-lived and resolve spontaneously, with the majority of affected individuals recovering within 10–14 days. However, complications can occur including prolonged symptoms or cognitive deficit, depression, and cumulative deterioration in brain function. The potential for adverse outcomes and the absence of direct measures of recovery following a concussive injury, make decisions regarding return to play a challenge. Clinical management includes confirming the diagnosis, differentiating concussion from structural head injury, estimating the severity of injury, and determining when the patient can return safely to competition. Players should return to play in a graded fashion after clinical features have resolved and cognitive function has returned to ‘normal’ on neuropsychological testing.

Keywords: wounds and injuries, athletic injuries; brain concussion

Traumatic brain injury and concussion
Traumatic brain injury (TBI) is a broad term that encompasses a spectrum of injuries to the brain resulting from trauma. On the...
severe end of the spectrum, TBI can result in demonstrable structural injury that may be focal (e.g., intracerebral, subarachnoid, subdural or extradural haemorrhage) or diffuse (e.g., petechial haemorrhages, cerebral oedema). Milder TBI results in a functional deficit, i.e., change in patterns of neuron activation, known as ‘concussion’. The Glasgow Coma Scale is commonly used in the clinical setting to monitor patients following TBI.14 The overall score (Glasgow Coma Score [GCS]) at 6 hours after injury, provides an estimate of injury severity – mild, moderate, and severe.15 Patients with sports related concussion typically have a GCS at 6 hours that indicates a ‘mild’ injury.

Pathophysiology of concussion

Concussion can be defined as a clinical syndrome of neurological impairment that results from traumatic biomechanical forces transmitted to the brain (either directly or indirectly).11,12 The clinical features typically come on rapidly after injury and resolve spontaneously over a sequential course. While the pathophysiology remains poorly understood, the current consensus is that concussion reflects a disturbance of brain function rather than a structural injury.11–13 Data derived from animal models of concussion suggest that linear acceleration or rotational shearing forces may result in short lived neurochemical, metabolic or gene-expression changes.16

Complications of concussion

Symptoms and signs following a concussive injury are typically temporary and resolve spontaneously and uneventfully within 10–14 days of injury. However, the process of recovery varies from person-to-person and injury-to-injury. A number of complications or adverse outcomes have been reported. These are summarised in Table 1.

Risk factors for complications or adverse outcomes remain unclear and genetic factors may play an important role.17 However, the current consensus is that premature return to play (and subsequent second injury) is often valuable. Any report that the individual ‘does not seem right’ or ‘is not themselves’ following trauma is strongly suggestive of a concussive injury.

A graded symptom checklist, such as that included in the Sport Concussion Assessment Tool 2 (SCAT2), is often helpful (see Resources). The SCAT2 was developed as part of the consensus statement produced after the Zurich expert meeting in 2008.13 Using a symptom checklist enables the range of symptoms commonly observed following concussion to be covered and provides a measure of symptom severity.

It is important to differentiate concussion from structural head injury. Clinical features that may raise concerns of structural head injury include:

- the mechanism of injury, particularly if high speeds, falls from height or high velocity projectiles (e.g., baseball or cricket ball) are involved
- progression of clinical features over time. Clinical features of concussion typically resolve within 10–14 days of injury. Any deterioration in clinical state, in particular worsening headache, nausea or vomiting, or deterioration in conscious state, should raise suspicion of a structural head injury and warrant further investigation. Similarly, structural head injury should be kept in mind in any case where symptoms persist beyond 10–14 days
- finding of any focal neurological deficit on clinical examination.

Conventional imaging techniques such as X-ray, computerised tomography (CT) and magnetic resonance imaging (MRI) are typically normal following acute concussion. These investigations should only be ordered if there is a suspicion of structural pathology.

Estimating the severity of injury

Over the years, numerous concussion severity scales have been proposed. The main objective of these scales has been to identify higher grades of concussion severity or increased potential for adverse outcomes and subsequently guide management. Many of the more popular scales, such as the Cantu classification system and Colorado guidelines, rely heavily on LOC to estimate injury severity and guide return to sport. Traditionally, impairment of consciousness was considered to be a hallmark of primary diffuse head injury, and the depth and duration of LOC to correlate with severity of brain injury.14 However, more recent studies on sports related concussion have consistently demonstrated that brief LOC does not reflect injury severity or predict time to recovery.16–20

At the First International Conference on Concussion in Sport the strengths and weaknesses of all existing injury severity scales were considered, however, none of the scales were endorsed.11 The expert consensus was that combined clinical measures of recovery should be used to assess injury severity and prognosis.11

At the most recent International Conference on Concussion in Sport, a range of clinical factors that may be associated with longer duration of symptoms or increased risk of adverse outcomes following concussive injury were identified.13,21 These ‘modifying’
Factors are summarised in Table 1. The presence of any ‘modifying’ factor after a concussive injury suggests the need for a more conservative approach, including more detailed assessment and slower time to return to sport. In this setting, referral to a neuropsychologist and/or doctor with expertise in managing concussive injuries should be considered.

### Timing of Return to Play

The decision regarding the timing of return to play following a concussive injury is a difficult one. Expert guidelines recommend that players should not be allowed to return to competition until they have recovered completely from their concussive injury. However, there is no single gold standard measure of brain disturbance and recovery following sports related concussion. Instead, clinicians must rely on indirect measures to inform clinical judgement. In practical terms this involves a comprehensive clinical approach, including:

- early rest – a period of cognitive and physical rest to facilitate recovery
- monitoring recovery of postconcussion symptoms and signs
- the use of neuropsychological tests to estimate recovery of cognitive function, and
- a graduated return to activity with monitoring for recurrence of symptoms.

### Early Rest

Early rest is important to allow recovery following a concussive injury. Physical activity, physiological stress (eg. altitude and flying) and cognitive loads (eg. school work, video games, computer) can all worsen symptoms and possibly delay recovery following concussion. Individuals should be advised to rest from these activities in the early stages after a concussive injury, especially while symptomatic. Specific advice should also be given on avoidance of activities that place the individual at risk of further injury, such as driving.

### Monitoring Recovery

The SCAT is a standardised method of evaluating and monitoring individuals following a concussive injury. However, the SCAT is an overall assessment tool, so some of its components (eg. Maddocks Questions, Glasgow Coma Score) are most useful in
Formal neuropsychological testing remains the clinical standard for the assessment of cognitive function and is recommended in any case where there is uncertainty about recovery or in difficult cases such as prolonged recovery. However, in most patients, screening neuropsychological tests are adequate when combined with a more conservative return to play plan. Ideally, the tests should be compared to the individual’s own pre-injury baseline. Where a baseline does not exist, which is common in the general practice setting, the test result can be compared to population normative data and the test repeated until the individual’s performance has stabilised.

A number of screening neuropsychological tests have been validated for use following concussion in sport and are readily available. These include simple paper and pencil tests such as the digit symbol substitution test, and computerised test platforms such as.

### Table 2. Concussion modifiers

<table>
<thead>
<tr>
<th>Factors</th>
<th>Modifier</th>
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<tbody>
<tr>
<td>Symptoms</td>
<td>High number, long duration (&gt;10 days), high severity</td>
</tr>
<tr>
<td>Signs</td>
<td>Prolonged loss of consciousness (&gt;1 minute), amnesia</td>
</tr>
<tr>
<td>Sequelae</td>
<td>Prolonged concussive convulsions*</td>
</tr>
<tr>
<td>Temporal</td>
<td>• Frequency – repeated concussions over time</td>
</tr>
<tr>
<td></td>
<td>• Timing – injuries close together in time</td>
</tr>
<tr>
<td></td>
<td>• ‘Recency’ – a recent concussion or traumatic brain injury</td>
</tr>
<tr>
<td>Threshold</td>
<td>Repeated concussions occurring with progressively less impact force or slower recovery after each successive concussion</td>
</tr>
<tr>
<td>Age</td>
<td>Child and adolescent (&lt;18 years of age)</td>
</tr>
<tr>
<td>Co- and pre-morbidities</td>
<td>Migraine, depression or other mental health disorders, attention deficit hyperactivity disorder, learning disabilities, sleep disorders</td>
</tr>
<tr>
<td>Medication</td>
<td>Psychoactive drugs, anticoagulants</td>
</tr>
<tr>
<td>Behaviour</td>
<td>Dangerous style of play</td>
</tr>
<tr>
<td>Sport</td>
<td>High risk activity, contact and collision sport, high sporting level</td>
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</tbody>
</table>

* Concussive convulsions or impact seizures are occasionally observed following concussion in sport. These are usually brief in duration (<1 minute) and range from tonic posturing to full tonic-clonic seizures. Brief concussive convulsions are benign, with no adverse clinical outcomes. Consequently, investigations are not required, anti-epileptic treatment is not indicated, and prolonged absence from sport is not warranted in the majority of cases.

### Table 3. Graduated return to play protocol

<table>
<thead>
<tr>
<th>Rehabilitation stage</th>
<th>Functional exercise</th>
<th>Objective</th>
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<tbody>
<tr>
<td>No activity</td>
<td>Complete physical and cognitive rest</td>
<td>Recovery</td>
</tr>
<tr>
<td>Light aerobic exercise</td>
<td>Walking, swimming or stationary cycling keeping intensity to less than 70% of maximum predicted heart rate  No resistance training</td>
<td>Increase heart rate</td>
</tr>
<tr>
<td>Sport specific exercise</td>
<td>Light training drills (eg. running, ball work); no head impact activities</td>
<td>Add movement</td>
</tr>
<tr>
<td>Noncontact training drills</td>
<td>Progression to more complex training drills. May start progressive resistance training</td>
<td>Exercise, coordination and cognitive load</td>
</tr>
<tr>
<td>Full contact practise</td>
<td>Following medical clearance participate in normal training activities</td>
<td>Restore confidence and assess functional skills by coaching staff</td>
</tr>
<tr>
<td>Return to play</td>
<td>Normal game play</td>
<td></td>
</tr>
</tbody>
</table>
CogState Sport (see Resources) or ImPACT™ (see Resources). Ideally, computerised test platforms should be used, however, paper and pencil tests (with a more conservative return to play approach) are useful in cases where costs and time restrictions limit the use of computerised testing. Overall, it is important to remember that neuropsychological testing is only one component of assessment, and should not be the sole basis of management decisions.

Graduated return to activity

Following a concussive injury, players should be returned to play in a graded fashion (Table 3) once clinical features have resolved and cognitive function returned to ‘normal’ on neuropsychological testing. A more conservative approach (ie. longer time to return to sport) should be used where there is any uncertainty about the player’s recovery – ‘if in doubt sit them out’.

Progression through the rehabilitation program should occur with 24 hours between stages. The player should be instructed that if any symptoms recur while progressing through their return to play program that they should drop back to the previous asymptomatic level and try to progress again after a further 24 hour period of rest.

Summary

Concussion in sport reflects a functional disturbance rather than a structural injury to the brain. The majority of individuals recover uneventfully following a concussive injury, however complications and adverse outcomes can occur, particularly with premature return to sport. The key components of safe return to play decisions include rest until all symptoms have resolved, neuropsychological testing to ensure objective recovery of cognitive function, and then a graded program of exertion before return to sport. In difficult or complicated cases, referral to a neuropsychologist and/or doctor with expertise in managing concussive injuries should be considered.

Resources

- SCAT2: http://bjsportmed.com/content/43/Suppl_1/i85.full.pdf
- CogState Sport: www.cogstate.com/go/Sport
- ImPACT™: www.impacttest.com.

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References

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