Consensus statement on concussion in sport: the 4th International Conference on Concussion in Sport held in Zurich, November 2012

Paul McCrory, Willem H Meeuwisse, Mark Aubry, Bob Cantu, Jiří Dvořák, Ruben J Echemendia, Lars Engbergren, Karen Johnston, Jeffrey S Kutcher, Martin Raftery, Allen Sills, Brian W Benson, Gavin A Davis, Richard G Ellenbogen, Kevin Guskiewicz, Stanley A Herring, Grant L Iverson, Barry D Jordan, James Kissick, Michael McCrea, Andrew S McIntosh, David Maddocks, Michael Makdissi, Laura Purcell, Margot Putukian, Kathryn Schneider, Charles H Tator, Michael Turner

PREAMBLE

This paper is a revision and update of the recommendations developed following the 1st (Vienna 2001), 2nd (Prague 2004) and 3rd (Zurich 2008) International Consensus Conferences on Concussion in Sport and is based on the deliberations at the 4th International Conference on Concussion in Sport held in Zurich, November 2012.

The new 2012 Zurich Consensus statement is designed to build on the principles outlined in the previous documents and to develop further conceptual understanding of this problem using a formal consensus-based approach. A detailed description of the consensus process is outlined at the end of this document under the Background section. This document is developed primarily for use by physicians and healthcare professionals who are involved in the care of injured athletes, whether at the recreational, elite or professional level.

While agreement exists pertaining to principal messages conveyed within this document, the authors acknowledge that the science of concussion is evolving, and therefore management and return to play (RTP) decisions remain in the realm of clinical judgement on an individualised basis. Readers are encouraged to copy and distribute freely the Zurich Consensus document, the Concussion Recognition Tool (CRT), the Sports Concussion Assessment Tool V3 (SCAT3) and/or the Child SCAT3 card and none are subject to any restrictions, provided they are not altered in any way or converted to a digital format. The authors request that the document and/or the accompanying tools be distributed in their full and complete format.

This consensus paper is broken into a number of sections:

1. A summary of concussion and its management, with updates from the previous meetings;
2. Background information about the consensus meeting process;
3. A summary of the specific consensus questions discussed at this meeting;
4. The Consensus paper should be read in conjunction with the SCAT3 assessment tool, the Child SCAT3 and the CRT (designed for lay use).

SECTION 1: SPORT CONCUSSION AND ITS MANAGEMENT

The Zurich 2012 document examines the sport concussion and management issues raised in the previous Vienna 2001, Prague 2004 and Zurich 2008 documents and applies the consensus questions from section 3 to these areas.

Definition of concussion

A panel discussion regarding the definition of concussion and its separation from mild traumatic brain injury (mTBI) was held. There was acknowledgement by the Concussion in Sport Group (CISG) that although the terms mTBI and concussion are often used interchangeably in the sporting context and particularly in the US literature, others use the term to refer to different injury constructs. Concussion is the historical term representing low-velocity injuries that cause brain 'shaking' resulting in clinical symptoms and that are not necessarily related to a pathological injury. Concussion is a subset of TBI and will be the term used in this document. It was also noted that the term commotio cerebri is often used in European and other countries. Minor revisions were made to the definition of concussion, which is defined as follows:

Concussion is a brain injury and is defined as a complex pathophysiological process affecting the brain, induced by biomechanical forces. Several common features that incorporate clinical, pathologic and biomechanical injury constructs that may be utilised in defining the nature of a concussive head injury include:

1. Concussion may be caused either by a direct blow to the head, face, neck or elsewhere on the body with an “impulsive” force transmitted to the head.
2. Concussion typically results in the rapid onset of short-lived impairment of neurological function that resolves spontaneously. However, in some cases, symptoms and signs may evolve over a number of minutes to hours.
3. Concussion may result in neuropathological changes, but the acute clinical symptoms...
largely reflect a functional disturbance rather than a structural injury and, as such, no abnormality is seen on standard structural neuroimaging studies.

4. Concussion results in a graded set of clinical symptoms that may or may not involve loss of consciousness. Resolution of the clinical and cognitive symptoms typically follows a sequential course. However, it is important to note that in some cases symptoms may be prolonged.

Recovery of concussion
The majority (80–90%) of concussions resolve in a short (7–10 day) period, although the recovery time frame may be longer in children and adolescents.2

Symptoms and signs of acute concussion
The diagnosis of acute concussion usually involves the assessment of a range of domains including clinical symptoms, physical signs, cognitive impairment, neurobehavioural features and sleep disturbance. Furthermore, a detailed concussion history is an important part of the evaluation both in the injured athlete and when conducting a preparticipation examination. The detailed clinical assessment of concussion is outlined in the SCAT3 and Child SCAT3 forms, which are given in the appendix to this document.

The suspected diagnosis of concussion can include one or more of the following clinical domains:

1. Symptoms—somatic (eg, headache), cognitive (eg, feeling like in a fog) and/or emotional symptoms (eg, lability);
2. Physical signs (eg, loss of consciousness (LOC), amnesia);
3. Behavioural changes (eg, irritable);
4. Cognitive impairment (eg, slowed reaction times);
5. Sleep disturbance (eg, insomnia).

If any one or more of these components are present, a concussion should be suspected and the appropriate management strategy instituted.

On-field or sideline evaluation of acute concussion
When a player shows ANY features of a concussion:

A. The player should be evaluated by a physician or other licensed healthcare provider onsite using standard emergency management principles and particular attention should be given to excluding a cervical spine injury.

B. The appropriate disposition of the player must be determined by the treating healthcare provider in a timely manner. If no healthcare provider is available, the player should be safely removed from practice or play and urgent referral to a physician arranged.

C. Once the first aid issues are addressed, an assessment of the concussive injury should be made using the SCAT3 or other sideline assessment tools.

D. The player should not be left alone following the injury and serial monitoring for deterioration is essential over the initial few hours following injury.

E. A player with diagnosed concussion should not be allowed to RTP on the day of injury.

Sufficient time for assessment and adequate facilities should be provided for the appropriate medical assessment both on and off the field for all injured athletes. In some sports, this may require rule change to allow an appropriate off-field medical assessment to occur without affecting the flow of the game or unduly penalising the injured player’s team. The final determination regarding concussion diagnosis and/or fitness to play is a medical decision based on clinical judgement.

Sideline evaluation of cognitive function is an essential component in the assessment of this injury. Brief neuropsychological test batteries that assess attention and memory function have been shown to be practical and effective. Such tests include the SCAT3, which incorporates the Maddocks’ questions4 5 and the Standardized Assessment of Concussion (SAC).6–8 It is worth noting that standard orientation questions (eg, time, place and person) have been shown to be unreliable in the sporting situation when compared with memory assessment.4 9 It is recognised, however, that abbreviated testing paradigms are designed for rapid concussion screening on the sidelines and are not meant to replace comprehensive neuropsychological testing which should ideally be performed by trained neuropsychologists who are sensitive to subtle deficits that may exist beyond the acute episode; nor should they be used as a stand-alone tool for the ongoing management of sports concussions.

It should also be recognised that the appearance of symptoms or cognitive deficit might be delayed several hours following a concussive episode and that concussion should be seen as an evolving injury in the acute stage.

Evaluation in the emergency room or office by medical personnel
An athlete with concussion may be evaluated in the emergency room or doctor’s office as a point of first contact following injury or may have been referred from another care provider. In addition to the points outlined above, the key features of this examination should encompass:

A. A medical assessment including a comprehensive history and detailed neurological examination including a thorough assessment of mental status, cognitive functioning, gait and balance.

B. A determination of the clinical status of the patient, including whether there has been improvement or deterioration since the time of injury. This may involve seeking additional information from parents, coaches, teammates and eyewitnesses to the injury.

C. A determination of the need for emergent neuroimaging in order to exclude a more severe brain injury involving a structural abnormality.

In large part, these points above are included in the SCAT3 assessment.

Concussion investigations
A range of additional investigations may be utilised to assist in the diagnosis and/or exclusion of injury. Conventional structural neuroimaging is typically normal in concussive injury. Given that caveat, the following suggestions are made: Brain CT (or where available an MR brain scan) contributes little to concussion evaluation but should be employed whenever suspicion of an intracerebral or structural lesion (eg, skull fracture) exists. Examples of such situations may include prolonged disturbance of the conscious state, focal neurological deficit or worsening symptoms.

Other imaging modalities such as fMRI demonstrate activation patterns that correlate with symptom severity and recovery in concussion.10–14 Although not part of routine assessment at the present time, they nevertheless provide additional insight to pathophysiological mechanisms. Alternative imaging technologies (eg, positron emission tomography, diffusion tensor imaging, magnetic resonance spectroscopy, functional connectivity), while demonstrating some compelling findings, are still at early stages of development and cannot be recommended other than in a research setting.
Published studies, using both sophisticated force plate technology, as well as those using less sophisticated clinical balance tests (eg, Balance Error Scoring System (BESS)), have identified acute postural stability deficits lasting approximately 72 h following sports-related concussion. It appears that postural stability testing provides a useful tool for objectively assessing the motor domain of neurological functioning, and should be considered as a reliable and valid addition to the assessment of athletes suffering from concussion, particularly where the symptoms or signs indicate a balance component.\textsuperscript{15–21}

The significance of Apolipoprotein (Apo) E4, ApoE promoter gene, Tau polymerase and other genetic markers in the management of sports concussion risk or injury outcome is unclear at this time.\textsuperscript{22,23} Evidence from human and animal studies in more severe traumatic brain injury demonstrates induction of a variety of genetic and cytokine factors such as: insulin-like growth factor 1 (IGF-1), IGF binding protein 2, Fibroblast growth factor, Cu-Zn superoxide dismutase, superoxide dismutase 1 (SOD-1), nerve growth factor, glial fibrillary acidic protein (GFAP) and S-100. How such factors are affected in sporting concussion is not known at this stage.\textsuperscript{24–31} In addition, biochemical serum and cerebro spinal fluid biomarkers of brain injury (including S-100, neuron-specific enolase (NSE), myelin basic protein (MBP), GFAP, tau, etc) have been proposed as a means by which cellular damage may be detected if present.\textsuperscript{32–38}

There is currently insufficient evidence, however, to justify the routine use of these biomarkers clinically.

Different electrophysiological recording techniques (eg, evoked response potential (ERP), cortical magnetic stimulation and electroencephalography) have demonstrated reproducible abnormalities in the postconcussive state; however, not all studies reliably differentiated concussed athletes from controls.\textsuperscript{39–45} The clinical significance of these changes remains to be established.

Neuropsychological assessment

The application of neuropsychological (NP) testing in concussion has been shown to be of clinical value and contributes significant information in concussion evaluation.\textsuperscript{46–51} Although cognitive recovery largely overlaps with the time course of symptom recovery in most cases, it has been demonstrated that cognitive recovery may occasionally precede or more commonly follow clinical symptom resolution, suggesting that the assessment of cognitive function should be an important component in the overall assessment of concussion and, in particular, any RTP protocol.\textsuperscript{52,53} It must be emphasised, however, that NP assessment should not be the sole basis of management decisions. Rather, it should be seen as an aid to the clinical decision-making process in conjunction with a range of assessments of different clinical domains and investigational results.

It is recommended that all athletes should have a clinical neurological assessment (including assessment of their cognitive function) as part of their overall management. This will normally be performed by the treating physician often in conjunction with computerised neuropsychological screening tools.

Formal NP testing is not required for all athletes; however, when this is considered necessary, it should ideally be performed by a trained neuropsychologist. Although neuropsychologists are in the best position to interpret NP tests by virtue of their background and training, the ultimate RTP decision should remain a medical one in which a multidisciplinary approach, when possible, has been taken. In the absence of NP and other (eg, formal balance assessment) testing, a more conservative RTP approach may be appropriate.

NP testing may be used to assist RTP decisions and is typically performed when an athlete is clinically asymptomatic; however, NP assessment may add important information in the early stages following injury.\textsuperscript{54–57} There may be particular situations where testing is performed early to assist in determining aspects of management, for example, return to school in a paediatric athlete. This will normally be determined in consultation with a trained neuropsychologist.\textsuperscript{56,57}

Baseline NP testing was considered by the panel and was not felt to be required as a mandatory aspect of every assessment; however, it may be helpful to add useful information to the overall interpretation of these tests. It also provides an additional educational opportunity for the physician to discuss the significance of this injury with the athlete. At present, there is insufficient evidence to recommend the widespread routine use of baseline neuropsychological testing.

Concussion management

The cornerstone of concussion management is physical and cognitive rest until the acute symptoms resolve and then a graded programme of exertion prior to medical clearance and RTP. The current published evidence evaluating the effect of rest following a sports-related concussion is sparse. An initial period of rest in the acute symptomatic period following injury (24–48 h) may be of benefit. Further research to evaluate the long-term outcome of rest, and the optimal amount and type of rest, is needed. In the absence of evidence-based recommendations, a sensible approach involves the gradual return to school and social activities (prior to contact sports) in a manner that does not result in a significant exacerbation of symptoms.

Low-level exercise for those who are slow to recover may be of benefit, although the optimal timing following injury for initiation of this treatment is currently unknown.

As described above, the majority of injuries will recover spontaneously over several days. In these situations, it is expected that an athlete will proceed progressively through a stepwise RTP strategy.\textsuperscript{58}

Graduated RTP protocol

RTP protocol following a concussion follows a stepwise process as outlined in table 1.

With this stepwise progression, the athlete should continue to proceed to the next level if asymptomatic at the current level. Generally, each step should take 24 h so that an athlete would take approximately 1 week to proceed through the full rehabilitation protocol once they are asymptomatic at rest and with provocative exercise. If any postconcussion symptoms occur while in the stepwise programme, then the patient should drop back to the previous asymptomatic level and try to progress again after a further 24 h period of rest has passed.

Same day RTP

It was unanimously agreed that no RTP on the day of concussive injury should occur. There are data demonstrating that at the collegiate and high school levels, athletes allowed to RTP on the same day may demonstrate NP deficits postinjury that may not be evident on the sidelines and are more likely to have delayed onset of symptoms.\textsuperscript{59–64}

‘Difficult’ or persistently symptomatic concussion patient

Persistent symptoms (>10 days) are generally reported in 10–15% of concussions. In general, symptoms are not specific to concussion and it is important to consider other pathologies.
Cases of concussion in sport where clinical recovery falls outside the expected window (ie, 10 days) should be managed in a multidisciplinary manner by healthcare providers with experience in sports-related concussion.

**Psychological management and mental health issues**

Psychological approaches may have potential application in this injury, particularly with the modifiers listed below. In the overall management of moderate-to-severe traumatic brain injury, duration of LOC is an acknowledged predictor of brain injury severity.73–75 In broad terms, this approach to management should be only considered by clinicians experienced in concussion management.

An important consideration in RTP is that concussed athletes should not only be symptom-free, but also they should not be taking any pharmacological agents/medications that may mask or modify the symptoms of concussion. Where antidepressant therapy may be commenced during the management of a concussion, the decision to RTP while still on such medication must be considered carefully by the treating clinician.

**Role of pharmacological therapy**

Pharmacological therapy in sports concussion may be applied in two distinct situations. The first of these situations is the management of specific and/or prolonged symptoms (eg, sleep disturbance, anxiety, etc). The second situation is where drug therapy is used to modify the underlying pathophysiology of the condition with the aim of shortening the duration of the concussion symptoms. In broad terms, this approach to management should be only considered by clinicians experienced in concussion management.

An important consideration in RTP is that concussed athletes should not only be symptom-free, but also they should not be taking any pharmacological agents/medications that may mask or modify the symptoms of concussion. Where antidepressant therapy may be commenced during the management of a concussion, the decision to RTP while still on such medication must be considered carefully by the treating clinician.

### Table 1  Graduated return to play protocol

<table>
<thead>
<tr>
<th>Rehabilitation stage</th>
<th>Functional exercise at each stage of rehabilitation</th>
<th>Objective of each stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. No activity</td>
<td>Symptom limited physical and cognitive rest</td>
<td>Recovery</td>
</tr>
<tr>
<td>2. Light aerobic exercise</td>
<td>Walking, swimming or stationary cycling keeping intensity &lt;70% maximum permitted heart rate No resistance training</td>
<td>Increase HR</td>
</tr>
<tr>
<td>3. Sport-specific exercise</td>
<td>Skating drills in ice hockey, running drills in soccer. No head impact activities</td>
<td>Add movement</td>
</tr>
<tr>
<td>4. Non-contact training drills</td>
<td>Progression to more complex training drills, eg, passing drills in football and ice hockey May start progressive resistance training</td>
<td>Exercise, coordination and cognitive load</td>
</tr>
<tr>
<td>5. Full-contact practice</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>6. Return to play</td>
<td>Normal game play</td>
<td></td>
</tr>
</tbody>
</table>

### Table 2  Concussion modifiers

<table>
<thead>
<tr>
<th>Factors</th>
<th>Modifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symptoms</td>
<td>Number Duration (&gt;10 days) Severity</td>
</tr>
<tr>
<td>Signs</td>
<td>Prolonged loss of consciousness (LOC) (&gt;1 min), Amnesia</td>
</tr>
<tr>
<td>Sequelea</td>
<td>Concussive convulsions</td>
</tr>
<tr>
<td>Temporal</td>
<td>Frequency—repeated concussions over time Timing—injuries close together in time “Recency”—recent concussion or traumatic brain injury (TBI)</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 old)</td>
</tr>
<tr>
<td>Comorbidities and premorbidities</td>
<td>Migraine, depression or other mental health disorders, attention deficit hyperactivity disorder (ADHD), learning disabilities (LD), 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>
</tr>
</tbody>
</table>
outcome. Although published findings in concussion describe LOC associated with specific, early cognitive deficits, it has not been noted as a measure of injury severity.\(^7\)\(^7\)\(^8\)\(^7\) Consensus discussion determined that prolonged (>1 min duration) LOC would be considered as a factor that may modify management.

Significance of amnesia and other symptoms
There is renewed interest in the role of post-traumatic amnesia and its role as a surrogate measure of injury severity.\(^44\)\(^79\)\(^80\) Published evidence suggests that the nature, burden and duration of the clinical postconcussive symptoms may be more important than the presence or duration of amnesia alone.\(^77\)\(^81\)\(^82\) Further, it must be noted that retrograde amnesia varies with the time of measurement postinjury and hence is poorly reflective of injury severity.\(^83\)\(^84\)

Motor and convulsive phenomena
A variety of immediate motor phenomena (eg, tonic posturing) or convulsive movements may accompany a concussion. Although dramatic, these clinical features are generally benign and require no specific management beyond the standard treatment of the underlying concussive injury.\(^85\)\(^86\)

Depression
Mental health issues (such as depression) have been reported as a consequence of all levels of traumatic brain injury including sports-related concussion. Neuroimaging studies using fMRI suggest that a depressed mood following concussion may reflect an underlying pathophysiological abnormality consistent with a limbic-frontal model of depression.\(^34\)\(^87\)–\(^89\) Although such mental health issues may be multifactorial in nature, it is recommended that the treating physician consider these issues in the management of concussed patients.

SPECIAL POPULATIONS
Child and adolescent athlete
The evaluation and management recommendations contained herein can be applied to children and adolescents down to the age of 13 years. Below that age, children report concussion symptoms different from adults and would require age-appropriate symptom checklists as a component of assessment. An additional consideration in assessing the child or adolescent athlete with a concussion is that the clinical evaluation by the healthcare professional may need to include both patient and parent input, and possibly teacher and school input when appropriate.\(^98\)–\(^104\) A child SCAT3 has been developed to assess concussion (see appendix) for individuals aged 5–12 years.

The decision to use NP testing is broadly the same as the adult assessment paradigm, although there are some differences. The timing of testing may differ in order to assist planning in school and home management. If cognitive testing is performed, then it must be developmentally sensitive until late teen years due to the ongoing cognitive maturation that occurs during this period, which in turn limits the utility of comparison to either the person’s own baseline performance or to population norms.\(^20\) In this age group, it is more important to consider the use of trained paediatric neuropsychologists to interpret assessment data, particularly in children with learning disorders and/or ADHD who may need more sophisticated assessment strategies.\(^54\)\(^57\)\(^98\)

It was agreed by the panel that no return to sport or activity should occur before the child/adolescent athlete has managed to return to school successfully. In addition, the concept of ‘cognitive rest’ was highlighted with special reference to a child’s need to limit exertion with activities of daily living that may exacerbate symptoms. School attendance and activities may also need to be modified to avoid provocation of symptoms. Children should not be returned to sport until clinically completely symptom-free, which may require a longer time frame than for adults.

Because of the different physiological response and longer recovery after concussion and specific risks (eg, diffuse cerebral swelling) related to head impact during childhood and adolescence, a more conservative RTP approach is recommended. It is appropriate to extend the amount of time of asymptomatic rest and/or the length of the graded exertion in children and adolescents. It is not appropriate for a child or adolescent athlete with concussion to RTP on the same day as the injury, regardless of the level of athletic performance. Concussion modifiers apply even more to this population than adults and may mandate more cautious RTP advice.

Elite versus non-elite athletes
All athletes, regardless of the level of participation, should be managed using the same treatment and RTP paradigm. The available resources and expertise in concussion evaluation are of more importance in determining management than a separation between elite and non-elite athlete management. Although formal NP testing may be beyond the resources of many sports or individuals, it is recommended that, in all organised high-risk sports, consideration be given to having this cognitive evaluation, regardless of the age or level of performance.

Chronic traumatic encephalopathy
Clinicians need to be mindful of the potential for long-term problems in the management of all athletes. However, it was agreed that chronic traumatic encephalopathy (CTE) represents a distinct tauopathy with an unknown incidence in athletic populations. It was further agreed that a cause and effect relationship has not as yet been demonstrated between CTE and concussions or exposure to contact sports.\(^103\)–\(^114\) At present, the interpretation of causation in the modern CTE case studies should proceed cautiously. It was also recognised that it is important to address the fears of parents/athletes from media pressure related to the possibility of CTE.

INJURY PREVENTION
Protective equipment—mouthguards and helmets
There is no good clinical evidence that currently available protective equipment will prevent concussion, although mouthguards have a definite role in preventing dental and oro-facial injury. Biomechanical studies have shown a reduction in impact forces to the brain with the use of head gear and helmets, but these findings have not been translated to show a reduction in concussion incidence. For skiing and snowboarding, there are a number of studies to suggest that helmets provide protection against head and facial injury and hence should be recommended for participants in alpine sports.\(^115\)–\(^118\) In specific sports such as cycling, motor and equestrian sports, protective helmets may prevent other forms of head injury (eg, skull fracture) that are related to falling on hard surfaces and may be an important injury prevention issue for those sports.\(^118\)–\(^119\)

Rule change
Consideration of rule changes to reduce the head injury incidence or severity may be appropriate where a clear-cut mechanism is implicated in a particular sport. An example of this is in football (soccer) where research studies demonstrated that upper limb to head contact in heading contests accounted for approximately 50% of concussions.\(^131\) As noted earlier, rule changes

may also be needed in some sports to allow an effective off-field medical assessment to occur without compromising the athlete’s welfare, affecting the flow of the game or unduly penalising the player’s team. It is important to note that rule enforcement may be a critical aspect of modifying injury risk in these settings, and referees play an important role in this regard.

Risk compensation
An important consideration in the use of protective equipment is the concept of risk compensation.112 This is where the use of protective equipment results in behavioural change such as the adoption of more dangerous playing techniques, which can result in a paradoxical increase in injury rates. The degree to which this phenomenon occurs is discussed in more detail in the review published in this supplement of the journal. This may be a matter of particular concern in child and adolescent athletes where the head injury rates are often higher than in adult athletes.113–115

Aggression versus violence in sport
The competitive/aggressive nature of sport that makes it fun to play and watch should not be discouraged. However, sporting organisations should be encouraged to address violence that may increase concussion risk.116–137 Fair play and respect should be supported as key elements of sport.

Knowledge transfer
As the ability to treat or reduce the effects of concussive injury after the event is minimal, education of athletes, colleagues and the general public is a mainstay of progress in this field. Athletes, referees, administrators, parents, coaches and healthcare providers need to be educated regarding the detection of concussion, its clinical features, assessment techniques and principles of safe RTP. Methods to improve education including web-based resources, educational videos and international outreach programmes are important in delivering the message. In addition, concussion working groups, plus the support and endorsement of enlightened sport groups such as Fédération Internationale de Football Association (FIFA), International Olympic Commission (IOC), International Rugby Board (IRB) and International Ice Hockey Federation (IIHF), who initiated this endeavour, have enormous value and must be pursued vigorously. Fair play and respect for opponents are ethical values that should be encouraged in all sports and sporting associations. Similarly, coaches, parents and managers play an important part in ensuring that these values are implemented on the field of play.58 138–150

SECTION 2: STATEMENT ON BACKGROUND TO THE CONSENSUS PROCESS
In November 2001, the 1st International Conference on Concussion in Sport was held in Vienna, Austria. This meeting was organised by the IIHF in partnership with FIFA and the Medical Commission of the IOC. As part of the resulting mandate for the future, the need for leadership and future updates was identified. The 2nd International Conference on Concussion in Sport was organised by the same group with the additional involvement of the IRB and was held in Prague, the Czech Republic, in November 2004. The original aims of the symposia were to provide recommendations for the improvement of safety and health of athletes who suffer concussive injuries in ice hockey, rugby, football (soccer) as well as other sports. To this end, a range of experts were invited to both meetings to address specific issues of epidemiology, basic and clinical science, injury grading systems, cognitive assessment, new research methods, protective equipment, management, prevention and long-term outcome.1 2

The 3rd International Conference on Concussion in Sport was held in Zurich, Switzerland on 29/30 October 2008 and was designed as a formal consensus meeting following the organisational guidelines set forth by the US National Institutes of Health. (Details of the consensus methodology can be obtained at: http://consensus.nih.gov/ABOUTCDP.htm.) The basic principles governing the conduct of a consensus development conference are summarised below:

1. A broad-based non-government, non-advocacy panel was assembled to give balanced, objective and knowledgeable attention to the topic. Panel members excluded anyone with scientific or commercial conflicts of interest and included researchers in clinical medicine, sports medicine, neuroscience, neuroimaging, athletic training and sports science.
2. These experts presented data in a public session, followed by inquiry and discussion. The panel then met in an executive session to prepare the consensus statement.
3. A number of specific questions were prepared and posed in advance to define the scope and guide the direction of the conference. The principal task of the panel was to elucidate responses to these questions. These questions are outlined below.
4. A systematic literature review was prepared and circulated in advance for use by the panel in addressing the conference questions.
5. The consensus statement is intended to serve as the scientific record of the conference.
6. The consensus statement will be widely disseminated to achieve maximum impact on both current healthcare practice and future medical research.

The panel chairperson (WM) did not identify with any advocacy position. The chairperson was responsible for directing the consensus session and guiding the panel’s deliberations. Panellists were drawn from clinical practice, academics and research in the field of sports-related concussion. They do not represent organisations per se, but were selected for their expertise, experience and understanding of this field.

The 4th International Conference on Concussion in Sport was held in Zurich, Switzerland on 1–3 November 2012 and followed the same outline as for the third meeting. All speakers, consensus panel members and abstract authors were required to sign an ICMJE Form for Disclosure of Potential Conflicts of Interest. Detailed information related to each author’s affiliations and conflicts of interests will be made publicly available on the CISG website and published with the BJSM supplement.

Medical legal considerations
This consensus document reflects the current state of knowledge and will need to be modified according to the development of new knowledge. It provides an overview of issues that may be of importance to healthcare providers involved in the management of sports-related concussion. It is not intended as a standard of care, and should not be interpreted as such. This document is only a guide, and is of a general nature, consistent with the reasonable practice of a healthcare professional. Individual treatment will depend on the facts and circumstances specific to each individual case.

It is intended that this document will be formally reviewed and updated prior to 1 December 2016.
 SECTION 3: ZURICH 2012 CONSENSUS QUESTIONS

Note that each question is the subject of a separate systematic review that is published in the BJSM (2013:47:5). As such, all citations and details of each topic will be covered in those reviews.

When you assess an athlete acutely and they do not have a concussion, what is it? Is a cognitive injury the key component of concussion in making a diagnosis?
The consensus panel agreed that concussion is an evolving injury in the acute phase with rapidly changing clinical signs and symptoms, which may reflect the underlying physiological injury in the brain. Concussion is considered to be among the most complex injuries in sports medicine to diagnose, assess and manage. A majority of concussions in sport occur without LOC or frank neurological signs. At present, there is no perfect diagnostic test or marker that clinicians can rely on for an immediate diagnosis of concussion in the sporting environment. Because of this evolving process, it is not possible to rule out concussion when an injury event occurs associated with a transient neurological symptom. All such cases should be removed from the playing field and assessed for concussion by the treating physician or healthcare provider as discussed below. It was recognised that a cognitive deficit is not necessary for acute diagnosis as it either may not be present or detected on examination.

Are the existing tools/examination sensitive and reliable enough on the day of injury to make or exclude a diagnosis of concussion?
Concussion is a clinical diagnosis based largely on the observed injury mechanism, signs and symptoms. The vast majority of sports-related concussions (hereafter, referred to as concussion) occur without LOC or frank neurological signs. In milder forms of concussion, the athlete might be slightly confused, without clearly identifiable amnesia. In addition, most concussions cannot be identified or diagnosed by neuroimaging techniques (eg, CT or MRI). Several well-validated neuropsychological tests are appropriate for use in the assessment of acute concussion in the competitive sporting environment. These tests provide important data on symptoms and functional impairments that clinicians can incorporate into their diagnostic formulation, but should not solely be used to diagnose concussion.

What is the best practice for evaluating an adult athlete with concussion on the ‘field of play’ in 2012?
Recognising and evaluating concussion in the adult athlete on the field is a challenging responsibility for the healthcare provider. Performing this task is often a rapid assessment in the midst of competition with a time constraint and the athlete eager to play. A standardised objective assessment of injury, which includes excluding more serious injury, is critical in determining disposition decisions for the athlete. The on-field evaluation of sports-related concussion is often a challenge given the elusiveness and variability of presentation, difficulty in making a timely diagnosis, specificity and sensitivity of sideline assessment tools, and the reliance on symptoms. Despite these challenges, the sideline evaluation is based on recognition of injury, assessment of symptoms, cognitive and cranial nerve function, and balance. Serial assessments are often necessary. Concussion is often an evolving injury, and signs and symptoms may be delayed. Therefore, erring on the side of caution (keeping an athlete out of participation when there is any suspicion for injury) is important. An SAC is useful in the assessment of the athlete with suspected concussion but should not take the place of the clinician’s judgement.

How can the SCAT2 be improved?
It was agreed that a variety of measures should be employed as part of the assessment of concussion to provide a more complete clinical profile for the concussed athlete. Important clinical information can be ascertained in a streamlined manner through the use of a multimodal instrument such as the Sport Concussion Assessment Tool (SCAT). A baseline assessment is advised wherever possible. However, it is acknowledged that further validity studies need to be performed to answer this specific issue.

A future SCAT test battery (ie, SCAT3) should include an initial assessment of injury severity using the Glasgow Coma Scale (GCS), immediately followed by observing and documenting concussion signs. Once this is complete, symptom endorsement and symptom severity, as well as neurocognitive and balance functions, should be assessed in any athlete suspected of sustaining a concussion. It is recommended that these latter steps be conducted following a minimum 15 min rest period on the sideline to avoid the influence of exertion or fatigue on the athlete’s performance. Although it is noted that this time frame is an arbitrary one, the expert panel agreed nevertheless that a period of rest was important prior to assessment. Future research should consider the efficacy for inclusion of vision tests such as the King Devick Test and clinical reaction time tests. Recent studies suggest that these may be useful additions to the sideline assessment of concussion. However, the need for additional equipment may make them impractical for sideline use.

It was further agreed that the SCAT3 would be suitable for adults and youths aged 13 and over and that a new tool (Child SCAT3) be developed for younger children.

Advances in neuropsychology: are computerised tests sufficient for concussion diagnosis?
Sports-related concussions are frequently associated with one or more symptoms, impaired balance and/or cognitive deficits. These problems can be measured using symptom scales, balance testing and neurocognitive testing. All three modalities can identify significant changes in the first few days following injury, generally with normalisation over 1–3 weeks. The presentation of symptoms and the rate of recovery can be variable, which reinforces the value of assessing all three areas as part of a comprehensive sport concussion programme.

Neuropsychological assessment has been described by the CSG as a ‘cornerstone’ of concussion management. Neuropsychologists are uniquely qualified to interpret neuropsychological tests and can play an important role within the context of a multifaceted-multimodal and multidisciplinary approach to managing sports-related concussion. Concussion management programmes that use neuropsychological assessment to assist in clinical decision-making have been instituted in professional sports, colleges and high schools. Brief computerised cognitive evaluation tools are the mainstay of these assessments worldwide, given the logistical limitation in accessing trained neuropsychologists; however, it should be noted that these are not substitutes for formal neuropsychological assessment. At present, there is insufficient evidence to recommend the widespread routine use of baseline neuropsychological testing.

What evidence exists for new strategies/technologies in the diagnosis of concussion and assessment of recovery?
A number of novel technological platforms exist to assess concussion including (but not limited to) iPhone/smart phone apps, quantitative electroencephalography, robotics—sensory motor...
assessment, telemedicine, eye-tracking technology, functional imaging/advanced neuroimaging and head impact sensors. At this stage, only limited evidence exists for their role in this setting and none have been validated as diagnostic. It will be important to reconsider the role of these technologies once evidence is developed.

Advances in the management of sport concussion: what is evidence for concussion therapies

The current evidence evaluating the effect of rest and treatment following a sports-related concussion is sparse. An initial period of rest may be of benefit. However, further research to evaluate the long-term outcome of rest, and the optimal amount and type of rest, is needed. Low-level exercise for those who are slow to recover may be of benefit, although the optimal timing following injury for initiation of this treatment is currently unknown. Multimodal physiotherapy treatment for individuals with clinical evidence of cervical spine and/or vestibular dysfunction may be of benefit. There is a strong need for high-level studies evaluating the effects of a resting period, pharmacological interventions, rehabilitative techniques and exercise for individuals who have sustained a sports-related concussion.

The difficult concussion patient—What is the best approach to investigation and management of persistent (>10 days) postconcussive symptoms?

Persistent symptoms (>10 days) are generally reported in 10–15% of concussions. This may be higher in certain sports (eg, elite ice hockey) and populations (eg, children). In general, symptoms are not specific to concussion and it is important to consider and manage co-existent pathologies. Investigations may include formal neuropsychological testing and conventional neuroimaging to exclude structural pathology. Currently, there is insufficient evidence to recommend routine clinical use of advanced neuroimaging techniques or other investigative strategies. Cases of concussion in sport where clinical recovery falls outside the expected window (ie, 10 days) should be managed in a multidisciplinary manner by healthcare providers with experience in sports-related concussion. Important components of management after the initial period of physical and cognitive rest include associated therapies such as cognitive, vestibular, physical and psychological therapy, consideration of assessment of other causes of prolonged symptoms and consideration of commencement of a graded exercise programme at a level that does not exacerbate symptoms.

Revisiting concussion modifiers: how should the evaluation and management of acute concussion differ in specific groups?

The literature demonstrates that the number and severity of symptoms and previous concussions are associated with prolonged recovery and/or increased risk of complications. Brief LOC, duration of post-traumatic amnesia and/or impact seizures do not reliably predict outcome following concussion, although a cautious approach should be taken in an athlete with prolonged LOC (ie, >1 min). Children generally take longer to recover from concussions and assessment batteries have yet to be validated in the younger age group. Currently, there are insufficient data on the influence of genetics and gender on outcome following concussion. Several modifiers are associated with prolonged recovery or increased risk of complications following concussion and have important implications for management. Children with concussion should be managed conservatively, with the emphasis on return to learn before return to sport. In cases of concussion managed with limited resources (eg, non-elite players), a conservative approach should also be taken such that the athlete does not return to sport until fully recovered.

What are the most effective risk reduction strategies in sport concussion?—from protective equipment to policy?

No new valid evidence was provided to suggest that the use of current standard headgear in rugby, or of mouthguards in American football, can significantly reduce players’ risk of concussion. No evidence was provided to suggest an association between neck strength increases and concussion risk reduction. There was evidence to suggest that eliminating body checking from Pee Wee ice hockey (ages 11–12 years) and fair-play rules in ice hockey were effective injury prevention strategies. Helmets need to be able to protect from impacts resulting in a head change in velocity of up to 10 m/s in professional American football, and up to 7 m/s in professional Australian football. It also appears that helmets must be capable of reducing head-resultant linear acceleration to below 50 g and angular acceleration components to below 1500 rad/s² to optimise their effectiveness. Given that a multifactorial approach is needed for concussion prevention, well-designed and sport-specific prospective analytical studies of sufficient power are warranted for mouthguards, headgear/helmets, facial protection and neck strength. Measuring the effect of rule changes should also be addressed by future studies, not only assessing new rule changes or legislation, but also alteration or reinforcement to existing rules.

What is the evidence for chronic concussion-related changes?—behavioural, pathological and clinical outcomes

It was agreed that CTE represents a distinct tauopathy with an unknown incidence in athletic populations. It was further agreed that CTE was not related to concussions alone or simply exposure to contact sports. At present, there are no published epidemiological, cohort or prospective studies relating to modern CTE. Owing to the nature of the case reports and pathological case series that have been published, it is not possible to determine the causality or risk factors with any certainty. As such, the speculation that repeated concussion or subconcussive impacts cause CTE remains unproven. The extent to which age-related changes, psychiatric or mental health illness, alcohol/drug use or co-existing medical or demencing illnesses contribute to this process is largely unaccounted for in the published literature. At present, the interpretation of causation in the modern CTE case studies should proceed cautiously. It was also recognised that it is important to address the fears of parents/athletes from media pressure related to the possibility of CTE.

From consensus to action—how do we optimise knowledge transfer, education and ability to influence policy?

The value of knowledge transfer (KT) as part of concussion education is increasingly becoming recognised. Target audiences benefit from specific learning strategies. Concussion tools exist, but their effectiveness and impact require further evaluation. The media is valuable in drawing attention to concussion, but efforts need to ensure that the public is aware of the right information. Social media as a concussion education tool is becoming more prominent. Implementation of KT models is one approach organisations can use to assess knowledge gaps; identify, develop and evaluate education strategies; and use the outcomes to facilitate decision-making. Implementing KT strategies requires a defined plan. Identifying the needs, learning styles and preferred learning strategies of target audiences, coupled with evaluation, should be
a piece of the overall concussion education puzzle to have an impact on enhancing knowledge and awareness.

Author affiliations
1The Florey Institute of Neuroscience and Mental Health, Heidelberg, Victoria, Australia
2Faculty of Kinesiology, Hotchkiss Brain Institute, University of Calgary, Calgary, Alberta, Canada
3Faculty of Medicine, Sport Injury Prevention Research Centre, Calgary, Alberta, Canada
4International Ice Hockey Federation, Switzerland
5IOC Medical Commission Games Group, Ottawa, Ontario, Canada
6Ottawa Sport Medicine Centre, Ottawa, Ontario, Canada
7Department of Neurosurgery, Boston University Medical Center, Boston, Massachusetts, USA
8Center for the Study of Traumatic Encephalopathy, Boston University Medical Center, Boston, Massachusetts, USA
9Department of Neurology, University of Zurich, Zurich, Switzerland
10Schulthess Clinic Zurich, Zurich, Switzerland
11F-MARC (FIFA Medical Assessment and Research Center), Zurich, Switzerland
12Psychological and Neurobehavioral Associates, Inc., State College, Pennsylvania, USA
13University of Missouri–Kansas City, Kansas City, Missouri, USA
14Department of Orthopaedic Surgery, Osaka University Hospital and Faculty of Medicine, University of Oslo, Norway
15Oso Sports Trauma Research Center, Norway
16International Olympic Committee (IOC), Lausanne, Switzerland
17Division of Neurosurgery, University of Toronto, Toronto, Canada
18Concussion Management Program Athletic Edge Sports Medicine, Toronto, Canada
19Michigan NeuroSport, Department of Neurology, University of Michigan, Ann Arbor, Michigan, USA
20International Rugby Board, Dublin, Ireland
21Department of Neurosurgery, Orthopaedic Surgery and Rehabilitation, Vanderbilt Sports Concussion Center, Vanderbilt University Medical Center, Nashville, Tennessee, USA
22Department of Clinical Neurosciences, Faculty of Medicine, University of Calgary, Calgary, Alberta, Canada
23Department of Family Medicine, University of Calgary, Calgary, Alberta, Canada
24Sport Medicine Centre, Faculty of Kinesiology, University of Calgary, Calgary, Alberta, Canada
25Department of Neurosurgery, Austin and Cabini Hospitals & The Florey Institute of Neuroscience and Mental Health, Melbourne, Victoria, Australia
26Theodore S. Roberts endowed Chair Department of Neurosurgical University of Washington Seattle, WA, USA
27NFL Head, Neck and Spine Medical Committee
28Matthew Gfeller Sport-Related Traumatic Brain Injury Research Center, University of North Carolina, Chapel Hill, Chapel Hill, North Carolina, USA
29Clinical Professor Departments of Rehabilitation Medicine, Orthopaedics and Sports Medicine and Neurological Surgery, University of Washington, USA
30Seattle Sports Concussion Program, Team Physician Seattle Seahawks and Seattle Mariners, Seattle, Washington, USA
31Department of Psychiatry, University of British Columbia, Vancouver, British Columbia, Canada
32Well Medical College of Cornell University, New York, New York, USA
33Burke Rehabilitation Hospital, White Plains, New York, USA
34New York State Athletic Commission, New York, New York, USA
35Department of Family Medicine, University of Ottawa, Ottawa, Canada
36Canadian National Men’s Sledge Hockey Team, Canada
37National Football League Players Association (NFLPA) Mackay-White Traumatic Brain Injury Committee
38Brain Injury Research, Departments of Neurosurgery and Neurology, Medical College of Wisconsin, Wisconsin, USA
39Australian Centre for Research into Injury in Sports and its Prevention, Monash Injury Prevention Centre, Victoria, Australia
40Department of Physical Therapy, Monash University, Clifden, Victoria, Australia
41Service for Women and Children’s Health, Royal Children’s Hospital, Melbourne, Victoria, Australia
42Sports Medicine and rehabilitation Centre, Victorian Institute of Sport, Melbourne, Victoria, Australia
43Department of Physical Therapy, Monash University, Victoria, Australia
44School of Physiotherapy, University of Queensland, Brisbane, Queensland, Australia
45School of Physiotherapy, University of Melbourne, Melbourne, Victoria, Australia
46Centre for Health Exercise and Sports Medicine, Melbourne Physiotherapy Department, University of Melbourne, Melbourne, Australia
47Department of Pediatrics, McMaster University, Hamilton, Ontario, Canada
48David Braley Sport Medicine and Rehabilitation Centre, McMaster University, Hamilton, Ontario, Canada
49Princeton University, New Jersey, USA
50Robert Wood Johnson, University of Medicine and Dentistry of New Jersey (UMDNJ), USA
51Sport Injury Prevention Research Centre, Faculty of Kinesiology, University of Calgary, Calgary, Alberta, Canada
52Toronto Western Hospital and University of Toronto, Toronto, Canada
53Krembil Neuroscience Centre, Toronto, Canada
54ThinkFirst Canada
55Parachute, Canada
56British Horseracing Authority, London, UK

Competing interests See the supplementary online data for competing interests (http://dx.doi.org/10.1136/bjsports-2013-092313).

Provenance and peer review Commissioned; internally peer reviewed.

REFERENCES
Concussion statement


11 of 12


Affiliation and disclosure statement for all authors in the BJSM 47:5 April IPHP issue

NB: All panelists received travel funding and accommodation from the Concussion in Sport Group to attend the Consensus meeting in Zurich, Switzerland

<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliations</th>
<th>Disclosures</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONSENSUS STATEMENT WRITING GROUP</td>
<td></td>
<td>Paul McCrory is a co-investigator, collaborator, or consultant on grants relating to mild TBI funded by several governmental organizations. He is Co-Chair of the Australian Centre for Research into Sports Injury and its Prevention (ACRISP), which is one of the International Research Centres for Prevention of Injury and Protection of Athlete Health supported by the International Olympic Committee (IOC). He has a clinical and consulting practice in general and sports neurology. He receives book royalties from McGraw-Hill and was employed in an editorial capacity by the British Medical Journal Publishing Group from 2001-2008. He has been reimbursed by the government, professional scientific bodies, and sporting bodies for presenting research relating to mild TBI and sport-related concussion at meetings, scientific conferences, and symposiums. He received consultancy fees in 2010 from Axon Sports (US) for the development of educational material (which was not renewed) and has received research funding since 2005 from CogState Inc. He is a cofounder and shareholder in two biomedical companies (involved in eHealth and Compression garment technologies) but does not hold any individual shares in any company related to concussion or brain injury assessment or technology. He did not receive any form of financial support directly related to this manuscript.</td>
</tr>
<tr>
<td>Paul McCrory MBBS PhD</td>
<td>Associate Professor, The Florey Institute of Neuroscience and Mental Health, Heidelberg, Australia</td>
<td></td>
</tr>
<tr>
<td>Willem H. Meeuwisse, MD, PhD</td>
<td>Professor and Co-Chair, Sport Injury Prevention Research Centre, Faculty of Kinesiology and Hotchkiss Brain Institute, Faculty of Medicine, University of Calgary, Calgary, Alberta, Canada</td>
<td>Willem Meeuwisse, MD, PhD has received research grant support through the University of Calgary from the Canadian Institutes of Health Research, Alberta Innovates Health Solutions, the International Football Association (FIFA), Alberta Children’s Hospital Research Institute and the Hotchkiss Brain Institute. He is Co-Chair of the Sport Injury Prevention Research Centre, which is one of the International Research Centres for Prevention of Injury and Protection of Athlete Health supported by the International Olympic Committee (IOC). He has a clinical and consulting practice in sport medicine at the University of Calgary Sport Medicine Centre with a focus on sport related concussion. He has received travel funding from FIFA and the Medical Commission of the IOC. From 1998-2012 he was the Editor-in-Chief of the Clinical Journal of Sport Medicine and received editorial support funding from Lippincott-Wolters Kluwer. He receives compensation as a medical consultant to the National Hockey League, may receive royalty from BKin Technologies, and is a shareholder of Safebrain Canada and PriviT Healthcare. He did not</td>
</tr>
</tbody>
</table>
Affiliation and disclosure statement for all authors in the BJSM 47:5 April IPHP issue

NB: All panelists received travel funding and accommodation from the Concussion in Sport Group to attend the Consensus meeting in Zurich, Switzerland

<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliations</th>
<th>Disclosures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mark Aubry MD, Dip. Sport Med.</td>
<td>Chief Medical Officer International Ice Hockey Federation, Switzerland; Member of the IOC Medical Commission Games Group, Co-Director Ottawa Sport Medicine Centre, Ottawa, Ontario, Canada</td>
<td>Mark Aubry M.D. Dip Sport Med. receives travel funding from the IIHF and IOC Medical Commission Games Group for meetings, IIHF Championships and Olympic Games. He did not receive any form of financial support directly related to this manuscript.</td>
</tr>
<tr>
<td>Robert C. Cantu, M.A., M.D.</td>
<td>Clinical Professor, Neurosurgery and Co-Director Center for the Study of Traumatic Encephalopathy, Boston University Medical Center, Boston, MA USA</td>
<td>Robert C. Cantu, M.A., M.D serves as Vice President, National Operating Committee on Standards for Athletic Equipment (NOCSAE), Co-Founder and Chairman Medical Director Sports Legacy (SLI), Waltham, MA, USA; Senior Advisor to NFL’s Head, Neck and Spine Committee, Expert witness Trial Testimony. He did not receive any form of financial support directly related to this manuscript.</td>
</tr>
<tr>
<td>Jiří Dvořák, MD, PhD</td>
<td>Professor of Neurology at the University of Zurich, Senior consultant Schulthess Clinic Zurich, Switzerland, Chairman F-MARC (FIFA Medical Assessment and Research Center)</td>
<td>Jiri Dvorak, MD, PhD, received compensation from his work at FIFA as FIFA Chief medical officer, no other compensations or grants have been received. He did not receive any form of financial support directly related to this manuscript.</td>
</tr>
<tr>
<td>Ruben J. Echemendia, Ph.D</td>
<td>Psychological and Neurobehavioral Associates, Inc., State College, PA, USA, Adjunct Associate Professor of Psychology, University of Missouri – Kansas City, USA</td>
<td>Ruben J. Echemendia, Ph.D. receives financial compensation as a consultant to the National Hockey League, Major League Soccer, and the U.S. Soccer Federation. He also receives financial compensation as a consultant to Princeton University and has served as a PI or co-PI on grants funded by NOCSAE, AMSSM, and the New Jersey Commission on Brain Injury Research. Dr. Echemendia maintains a private practice focused on clinical neuropsychology, sports neuropsychology, and forensic applications of neuropsychology. He did not receive any form of financial support directly related to this manuscript.</td>
</tr>
<tr>
<td>Lars Engebretsen MD PhD</td>
<td>Professor, Department of Orthopaedic Surgery, Oslo University Hospital and</td>
<td>Lars Engebretsen, MD, PhD has received research grant support through the University of Oslo from the Norwegian Institutes of Health Research, The Health South East, the</td>
</tr>
</tbody>
</table>
Affiliation and disclosure statement for all authors in the BJSM 47:5 April IPHP issue

NB: All panelists received travel funding and accommodation from the Concussion in Sport Group to attend the Consensus meeting in Zurich, Switzerland

<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliations</th>
<th>Disclosures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faculty of Medicine, University of Oslo, Norway. Co-chair Oslo Sports Trauma Research Center, Oslo, Norway. Head Scientific Activities, International Olympic Committee, Lausanne, Switzerland</td>
<td>International Football Association (FIFA), He is Co-Chair of the Sport Injury Prevention Research Centre, which is one of the International Research Centres for Prevention of Injury and Protection of Athlete Health supported by the International Olympic Committee (IOC). He is the professor and Chair of the Oslo University Orthopaedic department. He has been Editor-in-Chief of the BJSM IPHP From 2008. From January 2012 he has been co-editor of The Journal of Bone and Joints. He did not receive any form of financial support directly related to this manuscript.</td>
<td></td>
</tr>
<tr>
<td>Karen M. Johnston, MD, Ph.D</td>
<td>Neurosurgeon, Division of Neurosurgery, University of Toronto; Concussion Management Program Athletic Edge Sports Medicine, Toronto, Canada</td>
<td>Karen M. Johnston MD, Ph.D is a neurosurgeon subspecialized in brain trauma and has a clinical and research focus in sport concussion. She has received research funding through the CIHR, ONF and Innovation Fund, American College of Surgeons, McGill University, Pashby Sport Safety Fund and Think First Canada. She has independently consulted widely with many sport organizations however she has not and has never had a formal reimbursed affiliation with any sport team or sport governing body. She did not receive any form of financial support directly related to this manuscript.</td>
</tr>
<tr>
<td>Jeffrey S. Kutcher, MD</td>
<td>Associate Professor and Director, Michigan NeuroSport, Department of Neurology, University of Michigan, Ann Arbor, MI, USA</td>
<td>Jeffrey S. Kutcher, MD is the Director of Michigan NeuroSport, the University of Michigan's academic sports neurology program. He has received research grant support form the National Collegiate Athletic Association and ElMindA, Ltd. He is the Director of the National Basketball Association's Concussion Program and is a paid consultant for the National Hockey League Players’ Association. He is a current member of the National Football League Players’ Association's Mackey-White TBI Committee. He is also a consulting neurologist for the United States Ski and Snowboard Association. He was a founding member and the first Chairperson of the Sports Neurology Section of the American Academy of Neurology. He did not receive any form of financial support directly related to this manuscript.</td>
</tr>
<tr>
<td>Martin Raftery MB BS FACSP</td>
<td>Chief Medical Officer, International Rugby Board, Dublin, Ireland</td>
<td>No disclosures</td>
</tr>
<tr>
<td>Allen Sills, MD, FACS</td>
<td>Associate Professor of Neurosurgery, Orthopaedic Surgery and</td>
<td>Allen Sills, MD, FACS serves on the medical board of the Federation Equestrian Internationale (FEI) and has received travel funding from that organization. He did not receive any form of financial support directly related to this manuscript.</td>
</tr>
</tbody>
</table>
Affiliation and disclosure statement for all authors in the BJSM 47:5 April IPHP issue

NB: All panelists received travel funding and accommodation from the Concussion in Sport Group to attend the Consensus meeting in Zurich, Switzerland

<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliations</th>
<th>Disclosures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rehabilitation; Vanderbilt Sports Concussion Center, Vanderbilt University Medical Center, Nashville, Tennessee, USA</td>
<td>also serves as unpaid neurosurgical consultant to the US Equestrian Foundation, the Southeastern Conference (SEC) Working Group on Concussion, and the Nashville Predators (NHL) hockey team. He has a clinical practice in neurosurgery at the Vanderbilt University Medical Center with a focus on neurological problems in athletes. He did not receive any form of financial support directly related to this manuscript.</td>
<td></td>
</tr>
</tbody>
</table>

**CONSENSUS STATEMENT COAUTHORS**

<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliations</th>
<th>Disclosures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brian W. Benson, MD, PhD</td>
<td>Adjunct Research Assistant Professor, Department of Clinical Neurosciences, Faculty of Medicine; Clinical Assistant Professor, Department of Family Medicine; and Sport Medicine Centre, Faculty of Kinesiology, University of Calgary, Calgary, Alberta, Canada</td>
<td>Brian W. Benson, MD, PhD has a clinical and consulting practice in sport medicine at the University of Calgary Sport Medicine Centre with a focus on sport-related concussion. He also serves as Director of the Sport Concussion Clinic at the University of Calgary Sport Medicine Centre and may receive royalty from BKIN Technologies. He did not receive any form of financial support directly related to this manuscript.</td>
</tr>
<tr>
<td>Gavin A. Davis, MB.BS</td>
<td>Department of Neurosurgery, Austin and Cabrini Hospitals &amp; The Florey Institute of Neuroscience and Mental Health, Melbourne, Victoria, Australia</td>
<td>Gavin A. Davis, MB.BS. has received travel funding from FIFA. He did not receive any form of financial support directly related to this manuscript</td>
</tr>
<tr>
<td>Kevin M. Guskiewicz, PhD, ATC</td>
<td>Kenan Distinguished Professor and Chair, Department of Exercise and Sport Science; Co-Director, Matthew Gfeller Sport-Related Traumatic Brain Injury Research Center, University of North Carolina at Chapel Hill, Chapel Hill, NC; USA</td>
<td>Kevin Guskiewicz, PhD, ATC, serves on the NCAA’s Health and Safety Advisory Committee for Concussion, the NFL’s Head Neck and Spine Committee, and the NFLPA’s Mackey-White Committee; has received funding for travel and honoraria for lectures on sports concussion for professional organizations, including the IOC and FIFA; has given expert testimony on traumatic brain injury/concussion cases; and has received research funding from the National Institutes of Health, Centers for Disease Control and Prevention, National Operating Committee for Standards in Athletic Equipment, National Collegiate Athletic Association, NFL Charities, NFL Players’ Association, USA Hockey, and National Athletic Trainers’ Association. He did not receive any form of financial support directly related to this manuscript.</td>
</tr>
</tbody>
</table>
Affiliation and disclosure statement for all authors in the BJSM 47:5 April IPHP issue

NB: All panelists received travel funding and accommodation from the Concussion in Sport Group to attend the Consensus meeting in Zurich, Switzerland

<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliations</th>
<th>Disclosures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stanley A. Herring, MD</td>
<td>Clinical Professor Departments of Rehabilitation Medicine, Orthopaedics and Sports Medicine and Neurological Surgery, University of Washington; Co-Medical Director Seattle Sports Concussion Program, Team Physician Seattle Seahawks and Seattle Mariners, Seattle, Washington, USA</td>
<td>Stanley A. Herring, MD serves as a Member National Football League Head, Neck and Spine Committee; Member Football and Wellness Committee USA Football; Member Medical Advisory Board Pop Warner Football; Chair of Medical Advisory Board X2IMPACT, a non-financial position. Clinical and consulting practice at Harborview Medical Center focusing on the diagnosis and management of neurological and musculoskeletal injuries with particular interest in spinal disorders in active people and athletes and sports-related concussions. No form of financial support directly related to this manuscript was received.</td>
</tr>
<tr>
<td>Grant Iverson PhD</td>
<td>Neuropsychology Outcome Assessment Laboratory; Professor, Department of Psychiatry, University of British Columbia, Vancouver, BC, Canada</td>
<td>Grant Iverson, Ph.D. has been reimbursed by the government, professional scientific bodies, and commercial organizations for discussing or presenting research relating to mild TBI and sport-related concussion at meetings, scientific conferences, and symposiums. He has a clinical and consulting practice in forensic neuropsychology involving individuals who have sustained mild TBIs (including professional athletes). He has received research funding from several test publishing companies, including ImPACT Applications, Inc., CNS Vital Signs, and Psychological Assessment Resources (PAR, Inc.). He did not receive any form of financial support directly related to this manuscript.</td>
</tr>
<tr>
<td>Barry D. Jordan MD, MPH</td>
<td>Associate Professor of Clinical Neurology at Weill Medical College of Cornell University, New York, New York USA. Assistant Medical Director of the Burke Rehabilitation Hospital, White Plains, New York, USA. Chief Medical Officer of the New York State Athletic Commission. New York, New York USA. National Football League Players Association (NFLPA) Mackey-White Traumatic Brain Injury Committee.</td>
<td>Dr. Jordan has received financial compensation from the National Football League (NFL) Benefits Association for the establishment of a Neurocognitive Disability Benefit for retired players. He also has received financial compensation from Innovative CEUs for developing a medical-based high school coaching education program. In his position as the Chief Medical Officer of the New York State Athletic Commission, Dr. Jordan is a governor’s appointed public officer of the State of New York. He maintains an inpatient and outpatient clinical practice at the Burke Rehabilitation Hospital specializing in traumatic brain injury, dementia and sports neurology. Dr. Jordan did not receive any financial support related to this manuscript.</td>
</tr>
<tr>
<td>James Kissick MD, CCFP, Dip Sport Med</td>
<td>Sport Medicine Physician, Ottawa Sport Medicine Centre, Ottawa, Canada; Clinical</td>
<td>James Kissick has a clinical and consulting practice in sport and exercise medicine at the Ottawa Sport Medicine Centre. He did not receive any form of financial support directly related to this manuscript.</td>
</tr>
</tbody>
</table>
Affiliation and disclosure statement for all authors in the BJSM 47:5 April IPHP issue

NB: All panelists received travel funding and accommodation from the Concussion in Sport Group to attend the Consensus meeting in Zurich, Switzerland

<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliations</th>
<th>Disclosures</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lecturer, Dept of Family Medicine, University of Ottawa, Ottawa, Canada. Team Physician, Canadian National Men’s Sledge Hockey Team.</strong></td>
<td>related to this manuscript.</td>
<td></td>
</tr>
<tr>
<td>Michael McCrea, PhD, ABPP</td>
<td>Professor &amp; Director of Brain Injury Research, Departments of Neurosurgery and Neurology, Medical College of Wisconsin, WI, USA</td>
<td>Michael McCrea, PhD has been funded by the United States Department of Defense, U.S. Defense Veterans Brain Injury Center (DVBIC), NFL Charities, National Collegiate Athletic Association (NCAA), National Operating Committee on Standards for Athletic Equipment (NOCSAE), National Federation of High School Associations (NFHS), and other funding organizations over the past decade. Dr. McCrea is a member of the NFL Head, Neck and Spine Committee and has served on several U.S. national panels for scientific review and policy making relevant to sport-related concussion. He has been funded by BrainScope, Inc. for prior studies, but receives no direct compensation from BrainScope or other industry entities or sports organizations. Dr. McCrea is co-author of the Standardized Assessment of Concussion (SAC). He receives no financial compensation or support from publication or distribution of the SAC. He is currently principal investigator (PI) on a study by the U.S. Department of Defense comparing several computerized neurocognitive assessment tools for the assessment of sport-related concussion. He did not receive any form of financial support directly related to this manuscript.</td>
</tr>
<tr>
<td>Andrew S McIntosh, BAppSci (PT), MBiomedE, PhD</td>
<td>Adjunct Associate Professor Australian Centre for Research into Injury in Sports and its Prevention, Monash Injury Research Institute, Monash University, Adjunct Associate Professor, Transport and Road Safety Research, Faculty of Science, the University of New South Wales, Director, McIntosh Consultancy and Research Pty Ltd. Sydney, Australia</td>
<td>Andrew McIntosh in a self-employed consultant. In the area of sport and sports injury research he has received grant support through UNSW from the Australian Research Council, NSW Racing, the IRB, the ARU, and the AFL. As a consultant in the area of sport and sports injury he has undertaken paid work for the Australian Racing Board, McLaren F1, the IRB and Albion. He has received travel funding from the International Rugby Board, IIHF, FIFA and the Medical Commission of the IOC. He did not receive any form of financial support directly related to this manuscript.</td>
</tr>
<tr>
<td>David L. Maddocks, LLB, PhD</td>
<td>Barrister &amp; Solicitor, Perry Maddocks Trollope Lawyers, Melbourne, Australia.</td>
<td>David Maddocks, LLB, PhD has received research grant support through the Australian Football League (AFL). He provides consultancy medico-legal advice to the AFL. He has</td>
</tr>
</tbody>
</table>
Affiliation and disclosure statement for all authors in the BJSM 47:5 April IPHP issue

NB: All panelists received travel funding and accommodation from the Concussion in Sport Group to attend the Consensus meeting in Zurich, Switzerland

<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliations</th>
<th>Disclosures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Michael Makdissi, MBBS, PhD</td>
<td>Research Fellow, The Florey Institute of Neuroscience and Mental Health, Melbourne Brain Centre, Austin Campus, Melbourne, Australia. Research Fellow, Centre For Health Exercise and Sports Medicine, Melbourne Physiotherapy Department, University of Melbourne, Melbourne, Australia</td>
<td>Michael Makdissi, MBBS, PhD, has received research grant support through The Florey Institute of Neurosciences and Mental Health from the National Health and Medical Research Council, the Australian Football League (AFL) and AFL Medical Officers Association. He has received travel funding from FIFA. He has a clinical and consulting practice in sports medicine. He did not receive any form of financial support directly related to this manuscript.</td>
</tr>
<tr>
<td>Laura Purcell, MD, FRCPC</td>
<td>Associate Clinical Professor, Department of Pediatrics, McMaster University, Hamilton ON, Canada; Pediatric Sport Medicine Physician, David Braley Sport Medicine and Rehabilitation Centre, McMaster University, Hamilton ON, Canada; President, Paediatric Sport and Exercise Medicine Section, CPS</td>
<td>No disclosures</td>
</tr>
<tr>
<td>Margot Putukian, MD</td>
<td>Director of Athletic Medicine, Head Team Physician, Princeton University, Associate Clinical Professor, Robert Wood Johnson, University of Medicine and Dentistry of New Jersey (UMDNJ), USA</td>
<td>Margot Putukian MD has received research grant support through the new Jersey Commission on Brain Injury, the American Medical Society for Sports Medicine (AMSSM) and the National Operating Committee on Standards for Athletic Equipment (NOCSAE). She is the chair of the US Lacrosse Sports Science &amp; Safety Committee and also serves on the National Football League (NFL) Head Neck and Spine Committee, chairing the Return to Play subcommittee for the NFL. She works as a team physician for Princeton University, as well as team physician for the US Men’s National Lacrosse Team and for US Soccer. She is a consultant on concussion for the Center for Disease Controls (CDC) and the National Collegiate Athletic Association (NCAA). She is a past president for the AMSSM and currently is president of the AMSSM Foundation. Dr. Putukian does not receive any financial</td>
</tr>
</tbody>
</table>
Affiliation and disclosure statement for all authors in the BJSM 47:5 April IPHP issue

NB: All panelists received travel funding and accommodation from the Concussion in Sport Group to attend the Consensus meeting in Zurich, Switzerland

<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kathryn Schneider, PT, PhD</td>
<td>Sport Injury Prevention Research Centre, University of Calgary, Calgary, Alberta, Canada</td>
</tr>
<tr>
<td></td>
<td>Kathryn Schneider, PT, PhD has received research grant support through the University of Calgary from the Alberta Centre for Child, Family and Community Research. She has a clinical and consulting practice in physiotherapy at Evidence Sport and Spinal and Centric Health with a focus on sport related concussion. She did not receive any form of financial support directly related to this manuscript.</td>
</tr>
<tr>
<td>Charles H. Tator, MD, PHD</td>
<td>Professor of Neurosurgery, Toronto Western Hospital and University of Toronto, Canada; Senior Scientist, Krembil Neuroscience Centre, Toronto, Canada; Founder, ThinkFirst Canada; Board Member, Parachute Canada.</td>
</tr>
<tr>
<td></td>
<td>Charles Tator is a consultant to ImpaKt Protective, and is co-chair of the Concussion Awareness and Recognition Committee of the Ontario Neurotrauma Foundation. He is Chair of ThinkFirst’s Concussion Education and Awareness Committee, and Project Director of the Canadian Sports Concussion Project at the Krembil Neuroscience Centre. He is Director of the Ontario Concussion Centres Consortium. He has received research grants from many public sources including the Canadian Institute for Health Research, and the Ontario Brain Institute. He did not receive any financial support related to this manuscript.</td>
</tr>
<tr>
<td>Michael Turner MB BS</td>
<td>Chief Medical Adviser, British Horseracing Authority, London, United Kingdom</td>
</tr>
<tr>
<td></td>
<td>Michael Turner is employed as Chief Medical Adviser by the British Horseracing Authority and the Lawn Tennis Association. He has received travel funding from FIFA, the IOC, the ACSM and Gruppoforte (Physiomind) for attending conferences and lecturing. In addition to travel funding, most conference organisers also provided free Registration and support for accommodation. He did not receive any form of financial support directly related to this manuscript.</td>
</tr>
</tbody>
</table>

OTHER REVIEW AUTHORS

<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mick Molloy MD</td>
<td>Department of Medicine, University College, Cork, Ireland</td>
</tr>
<tr>
<td></td>
<td>No disclosures</td>
</tr>
<tr>
<td>Johna Register-Mihalik PhD</td>
<td>Senior Research Associate, Emergency Services Institute, WakeMed Health and Hospitals, Raleigh, NC; USA; Adjunct</td>
</tr>
<tr>
<td></td>
<td>Johna Register-Mihalik, PhD, LAT, ATC serves on the Board of Directors for the Brain Injury Association of North Carolina; has received funding for travel and honoraria for lectures on concussion in sport for professional organizations and has received funding from the</td>
</tr>
</tbody>
</table>
Affiliation and disclosure statement for all authors in the BJSM 47:5 April IPHP issue

NB: All panelists received travel funding and accommodation from the Concussion in Sport Group to attend the Consensus meeting in Zurich, Switzerland

<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliations</th>
<th>Disclosures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assistant Professor</td>
<td>Department of Exercise and Sport Science, University of North Carolina at Chapel Hill, Chapel Hill, NC, USA</td>
<td>National Operating Committee for Standards in Athletic Equipment, National Football League Charities, and center grant funding form the National Institutes of Health (North Carolina Translational and Clinical Science Institute). She did not receive any form of financial support directly related to this manuscript.</td>
</tr>
<tr>
<td>Stephen A Macciocchi PhD</td>
<td>Shepherd Center, Atlanta, Georgia, USA</td>
<td>No disclosures</td>
</tr>
<tr>
<td>Gerard A Gioia PhD</td>
<td>Children’s National Medical Center &amp; George Washington University School of Medicine, Rockville, Maryland, USA</td>
<td>Gerard A. Gioia, Ph.D. has received research grant support through the CDC and NIH as well as the USA Hockey Foundation. He serves as a consultant to multiple school systems in the Baltimore-Washington region. Dr. Gioia maintains a clinical practice focused on clinical neuropsychology and sports neuropsychology. He receives royalties as a co-author of the Behavior Rating Inventory of Executive Function (BRIEF) and Tasks of Executive Control (TEC). He is a co-author of the Pediatric ImPACT test battery, funded through the CDC, and has not received direct financial compensation for its development. He did not receive any form of financial support directly related to this manuscript.</td>
</tr>
<tr>
<td>Paul Comper PhD</td>
<td>Kinesiology and Physical Education &amp; Graduate Department of Rehabilitation Science, University of Toronto, Ontario, Canada</td>
<td>PC receives financial compensation as a consultant to the National Hockey League Players’ Association. He did not receive any form of financial support directly related to this manuscript.</td>
</tr>
<tr>
<td>Steven P. Broglio PhD</td>
<td>Michigan NeuroSport, School of Kinesiology, University of Michigan, MI, USA</td>
<td>Dr Broglio is a member of Michigan NeuroSport and currently has research support from ElMindA, Ltd, the National Athletic Trainers’ Association – Research and Education Foundation, the National Institutes of Health – National Institute of Neurological Disorders and Stroke, National Collegiate Athletic Association, and the Women’s Sports, Health and Activity Research and Policy (SHARP) Center. These funds were not used to support this manuscript.</td>
</tr>
<tr>
<td>Alain Ptito PhD</td>
<td>Department of Psychology, McGill University Health Centre, Cognitive Neuroscience Unit, Montreal Neurological Institute and Hospital &amp; Department of Neurology and Neurosurgery, McGill</td>
<td>Alain Ptito is Director of the Department of Psychology at the MUHC and Professor of Neurology and Neurosurgery at McGill University. He has received research grants from several public sources including the Canadian Institute for Health Research, and the Ontario Neurotrauma Foundation. He is also a consultant neuropsychologist specializing in traumatic brain injury/concussion in athletes and motor vehicle accident victims. He did</td>
</tr>
</tbody>
</table>
Affiliation and disclosure statement for all authors in the BJSM 47:5 April IPHP issue

NB: All panelists received travel funding and accommodation from the Concussion in Sport Group to attend the Consensus meeting in Zurich, Switzerland

<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliations</th>
<th>Disclosures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carolyn A Emery PhD</td>
<td>Faculty of Kinesiology, Sport Injury Prevention Research Centre, University of Calgary, Calgary, Alberta, Canada</td>
<td>CAE is supported by a Population Health Investigator Award from the Alberta Innovates Health Solutions. She also holds a Professorship in Pediatric Rehabilitation funded through the Alberta Children’s Hospital Foundation. She co-chairs the Sport Injury Prevention research Centre at the University of Calgary funded by the International Olympic Committee (IOC).</td>
</tr>
<tr>
<td>Jon Patricios MD</td>
<td>Sports Concussion South Africa, Johannesburg, South Africa</td>
<td>Dr Jon Patricios received funding from the South African Rugby Union through its BokSmart injury prevention programme to attend the Concussion in Sport Consensus meeting.</td>
</tr>
<tr>
<td>Christine Provvidenza PhD</td>
<td>Parachute (Formerly Safe Communities Canada, Safe Kids Canada, SMARTRISK, and ThinkFirst Canada), Toronto, Ontario, Canada</td>
<td>No disclosures</td>
</tr>
<tr>
<td>Andrew Gardner PsyD</td>
<td>Centre for Translational Neuroscience and Mental Health, School of Medicine &amp; Public Health, University of Newcastle, NSW, Australia.</td>
<td>No disclosures</td>
</tr>
<tr>
<td>Richard G. Ellenbogen, MD, FACS</td>
<td>Professor and Chairman Theodore S. Roberts Endowed Chair Department of Neurological Surgery University of Washington Seattle, WA, USA Co-Chair, NFL Head, Neck and Spine Medical Committee</td>
<td>None (National Football League, Volunteer Consultant to Commissioner . No financial remunerations received.)</td>
</tr>
</tbody>
</table>