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Implementation of the 2017 Berlin Concussion in Sport Group Consensus Statement in contact and collision sports: a joint position statement from 11 national and international sports organisations

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ABSTRACT

The 2017 Berlin Concussion in Sport Group Consensus Statement provides a global summary of best practice in concussion prevention, diagnosis and management, underpinned by systematic reviews and expert consensus. Due to their different settings and rules, individual sports need to adapt concussion guidelines according to their specific regulatory environment. At the same time, consistent application of the Berlin Consensus Statement's themes across sporting codes is likely to facilitate superior and uniform diagnosis and management, improve concussion education and highlight collaborative research opportunities. This document summarises the approaches discussed by medical representatives from the governing bodies of 10 different contact and collision sports in Dublin, Ireland in July 2017. Those sports are: American football, Australian football, basketball, cricket, equestrian sports, football/soccer, ice hockey, rugby league, rugby union and skiing. This document had been endorsed by 11 sport governing bodies/national federations at the time of being published.

INTRODUCTION

The Fifth International Conference on Concussion in Sport was held in Berlin, October 2016. The subsequent 2017 Concussion in Sport Group Consensus Statement¹ (underpinned by 12 systematic reviews^{2–13}), and accompanying sports concussion tools^{14–16} were intended to assist the clinician in the diagnosis and management of sport-related concussion. One important message from the Conference on Concussion in Sport was that other meetings would be needed to examine, develop and implement practical, sport-specific strategies for diagnosing and managing concussion across varying ages and levels of participation.

Representatives from 10 sports (American football, Australian football, basketball, cricket, equestrian sports, football/soccer, ice hockey, rugby league, rugby union and skiing) and 11 sport governing bodies/federations (Australian Football League (AFL), Gaelic Athletics Association,

International Ice Hockey Federation, International Ski Federation, National Hockey League (NHL), Hockey Canada, National College Athletics Association, National Football League (NFL), National Rugby League (NRL), World Rugby (WR) and the English Football Association) met in Dublin, Ireland from 20 to 22 July 2017. Cricket (represented by the England and Wales Cricket Board (ECB) and the International Cricket Association) and the International Basketball Federation attended as observers.

Despite the common 'collision element', each sport is governed by different laws and interchange rules. Some codes/sports have free-interchange, while others have stricter substitution laws, which can affect concussion management. The purpose of the Dublin meeting was to harmonise interpretation of the Berlin Concussion in Sport Group Consensus Statement recommendations, discuss impediments to implementation, exchange information on current practice and identify areas for collaboration among team collision sports. This position statement is a summary of the key discussion points, specific to team collision sports, and aims to clarify issues in implementation that are specific to the sports represented at the Dublin meeting. Many of the points covered apply to all contact sports while, where issues are sport-specific, these are framed in the context of the particular sport.

The following eight sections, and accompanying boxes represent the key themes discussed at the Dublin meeting, and highlight key clinical implications for collision sports.

Defining and diagnosing concussion in sport

The fundamental starting point for the clinician is to make the diagnosis of concussion. Accurate and timely diagnosis may help facilitate earlier recovery, reduce the risk of early complications and avoid further head and musculoskeletal injuries. Making an accurate diagnosis is both important and challenging because of concussion's varied and sometimes subtle presentation. Symptoms overlap with other musculoskeletal, psychological and neurological diagnoses and a lack of definitive investigations



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Table 1 Mandatory signs of concussion and appropriate action

Signs	Action
Loss of consciousness	Remove the athlete from the field of play
Lying motionless for >5s*	In some codes (eg, AFL, NRL, NFL, WR), the athlete may not return to the game once removed for a mandatory sign (referred to as 'no-go' criteria in the NFL). In other codes, a mandatory sign results in a mandatory assessment conducted in a distraction-free environment to determine whether to allow the player to return to the field of play.
Confusion/disorientation	
Amnesia	
Vacant look	
Motor incoordination	
Tonic posturing	
Impact seizure	
Ataxia	

*NRL and AFL use >1 s as a discretionary sign for an off-field assessment.
AFL, Australian Football League; NFL, National Football League; NRL, National Rugby League; WR, World Rugby.

or diagnostic markers raises challenges. Because of these issues, concussion remains a clinical diagnosis.

The first step in diagnosing concussion is to identify the potential injury, and evaluate the athlete. At all playing levels of all collision sports, a concussion evaluation is triggered when an athlete is identified as having experienced a forceful impact directly or indirectly transmitted to the head that was associated with:

- ▶ Symptom(s) reported by the athlete;
- ▶ Visible signs;
- ▶ Any clinical suspicion by medical staff.

Match officials may also report *possible concussion* to team clinicians. Some sports have implemented education programmes aimed at training match officials to recognise possible concussion and act by stopping the game and notifying the appropriate team clinicians.

In community-level sport, there may not be adequately trained medical staff present. In this situation, *any suspicion* by a match official, coach, athletic trainer, first aider or dedicated observer should result in removal of the athlete from the field of play.

Signs of concussion and expected actions

A number of sporting codes refer to *mandatory* or *discretionary* visible signs of concussion, which may guide the immediate course of action (tables 1 and 2). The signs defined as *mandatory* and *discretionary* may differ, as may the course of action. In some sports (AFL, NFL, NRL, rugby), mandatory signs indicate immediate removal from the field of play. In other sports (NHL), mandatory signs are indications for a mandatory off-field evaluation.

Table 2 Discretionary signs of concussion and appropriate action

Signs	Action
Clutching the head*	Further evaluation is required.
Being slow to get up*	The athlete should (1) be removed from the arena, (2) undergo an evaluation in a distraction-free environment and (3) only return to sport if the signs are determined to have been from a cause other than concussion (ie, the diagnosis of concussion is ruled out).
Suspected facial fracture	
Possible ataxia	
Behaviour change†	
Other clinical suspicion	

*NHL discretionary signs *slow to get up* or *clutching the head* do not require removal from play. The clinician should exercise his or her medical judgement regarding whether to remove the player for an acute evaluation.

†Some codes such as NRL, AFL and WR consider this a definitive removal criterion.
AFL, Australian Football League; NHL, National Hockey League; NRL, National Rugby League; WR, World Rugby.

A mandatory or discretionary sign *in combination with* a mechanism of injury involving head contact significantly increases the likelihood of a diagnosis of concussion.¹⁷

It is possible to diagnose concussion immediately. However, due to delayed presentation, excluding a diagnosis of concussion may take up to 48 hours following head contact. During this period – whether the athlete continues to play, or not – serial evaluations, as described in the Berlin Consensus Statement, should be completed by a medical practitioner. The Sports Concussion Assessment Tool (SCAT5)¹⁴ (either complete or in part) and Concussion Recognition Tool (CRT5)¹⁵ should be used to trigger or when conducting initial evaluations. The SCAT5 should be used for serial evaluations (described in the 'Management on and around the field of play' section).

The 'stunned' athlete, who has very short-lived, temporary signs or symptoms that fall within the current definition of concussion, could have a pathological process or injury type that may in the future be proven to be transient and not necessarily reflect a concussion. In these instances, some codes have implemented *temporary removal* for an evaluation and, no matter what the outcome, this should be followed by further serial assessments. If doubt exists, the athlete should not return to the field of play that day.

Sport-specific challenges for diagnosis and management of concussion

In sports that do not have a *replacement policy* (eg, football/soccer), there may be additional challenges contributing to increased pressure on athletes to under-report symptoms. Clinicians are at a significant disadvantage when required to make 'on-the-run' and 'on-the-field' decisions with insufficient time for an appropriate evaluation. Sports in which the laws do not facilitate the recommended 10 min off-field assessment should look to policymakers to make law changes rather than expecting clinicians to compromise the concussion evaluation and, possibly, athlete safety.

Using video to identify a concussion

Video might be used to trigger a concussion evaluation, or to help the clinician diagnose concussion. At the professional level, AFL, NFL, NHL, NRL and rugby union use video to identify possible concussion events, differentiate between mandatory and discretionary concussion signs and, in select cases, assist with return to sport decisions. Video-review improves the sensitivity of concussion identification and accurate identification of the mechanism(s) of injury.¹⁸ Clinicians can view (with replay, slow-motion and multiple viewing angles) the incident, often from perspectives that are not observable on the sideline.

Video has three important functions:

1. *Identification*: video can help the clinician identify suspicious events, and evaluate the athlete's response immediately following the event.
2. *Confirmation*: video can support the confirmation of mandatory versus discretionary signs.
3. *Management*: video can support return to sport decisions if the off-field concussion screening is normal.

Considerations for getting the most out of video technology

Based on the experience of collision sports using video technology, there are eight suggestions that should be considered for optimising video technology to support team clinicians with concussion diagnosis and management:

Box 1 Six key video-review steps for the team clinician

1. *Look for the suspected head impact event.*
2. *Look for the immediate response of the injured athlete (0–2 s): does the athlete fall to the ground? If the athlete falls, is there loss of head and neck control? Does the athlete protect himself/herself when falling? If the athlete remains upright, is he/she steady on his/her feet?*
3. *Look for the subsequent response (2–5 s): if the athlete falls, does he/she move spontaneously? Is there evidence of purposeful voluntary movement (ie, placing the ball or completing a tackle)? Is there evidence of a convulsive convulsion or tonic posturing? How does the athlete respond to the attending medical staff (this phase may extend for substantially longer than 5 s, particularly if in-line cervical immobilisation is required)? If the athlete remains standing, the distinction between the subsequent and late responses may be unclear.*
4. *Watch for the athlete's late response when returning to his/her feet (if the athlete has fallen): is the athlete unsteady when attempting to get to his/her feet and return to sport? Does the athlete need help from others to stand up? Are the athlete's movements fluid and coordinated? Does the athlete fall to the ground?*
5. *Watch the athlete's behaviour on return to sport. Are his/her actions appropriate or not? Does he/she move immediately to the correct position on the field of play?*
6. *Observe the responses of other athletes and match officials.*

1. Use a live television feed plus dedicated multiangle camera systems;
2. Use several camera views (although too many angles may delay clinical decision-making);
3. Employ trained 'spotters'/video review analysts who have injury expertise (eg, athletic trainers);
4. Competency is as important as qualification. Develop the competency (including using dedicated video training) of spotters and clinicians, irrespective of background training (ie, medical or non-medically trained);
5. Include video clips in the athlete's medical record;
6. Provide regular (eg, weekly) follow-up and feedback to spotters and clinicians, and review of collisions following each match to improve consistency;
7. When possible encourage camera operators to remain focused on a player for a fixed period of time (eg, 2 min) after a head impact;
8. Use a central, off-site broadcast 'bunker' with several monitors (instead of 'in-arena' monitoring).

It is acknowledged that not all criteria are always attainable and that broadcasters often dictate camera operation.

Tips for the team clinician using video to identify concussion

Video is useful for triggering a concussion evaluation, and may be one of the tools available to the clinician (one approach is outlined in [box 1](#)). However, video is *not* the sole criterion for concussion diagnosis. Take care when interpreting player responses to head impact events using the 'ultra-slo-mo' video capture. This is because ultra-slo-mo may exaggerate aspects such as the duration of eye closure.

Management on and around the field of play

In most sports, an initial on-field or pitch-side screen is conducted by an athletic trainer or team physician. The Maddocks' questions¹⁹ or similar sports-specific questions are often part of the on-field assessment. Depending on the sport's protocols, this process may also be initiated by a video spotter, independent match doctor or match official.

Immediate concussion management in recreational sport (where specialist support may be absent)

At community level, across all codes, CRT5 should be used to identify situations where athletes should be removed from sport because of possible concussion.¹⁵ Any suspicion of concussion should result in the athlete being removed from the playing arena. The athlete should not return to sport until an appropriate medical evaluation has been completed by an appropriately qualified healthcare professional. As per standard head-and-neck injury protocol, attention is also focused on appropriate management of potential cervical spine, maxillofacial and airway injuries.

Immediate concussion management in elite athletes (where specialist support is present)

If the brief on-field or pitch-side screen is suggestive of concussion, a more *thorough off-field assessment* in a distraction-free, private area should follow. This evaluation should be based on the SCAT5¹⁴ and performed by an accredited medical practitioner or trained healthcare professional. The rules of contact and collision sports should allow for a minimum of 10 min for this off-field evaluation,¹⁶ which may include video review (see below). Sport-specific modifications to the SCAT5 (eg, performing balance assessments with ice skates on) may be necessary to more closely replicate the typical conditions of the sport. Making the SCAT5 (or similar tool) available as a specialised software application on electronic devices can also provide immediate comparison to baseline scores. Consideration (as in the NRL) should be given for an extra 10 min if a second head injury evaluation (for another player) is required within 10 min of a concussion evaluation, and additional medical personnel are not available to evaluate both players.

Field of play management is facilitated more easily in interchange sports. In substitution sports without free interchange, a minimum period of 10 min allows for a SCAT5-type evaluation. Permitting longer periods of time for off-field head injury assessment may have the potential to contribute to an increased risk for game manipulation ('gaming') by uninjured players. In sports without free substitution for concussion, clinical evaluation and management may be compromised as both athletes and medical staff may feel pressure to keep athletes on the field. This could mean that athletes and clinicians may not allow sufficient time for the clinical features of the injury (eg, symptoms) to become evident. Where sporting codes do not facilitate an appropriate process for concussion evaluation, a change in the laws/rules of the sport should be encouraged to enhance athlete health and safety. This has been achieved in several codes (AFL, NFL, NRL, WR) by initiating dialogue between medical commissions and governing bodies that resulted in changes that support consensus guidelines and best practice.

Return to sport recommendations

The timing of return to sport is often the most important issue for athletes, coaches and parents. Clinicians face the challenge of

Box 2 Criteria for return to sport after concussion in team collision sport

Athletes who have been diagnosed with concussion, may only return to sport after:

1. Concussion-related *symptom scores, at rest and with match-intensity exercise, have returned to baseline levels.*
2. *Neurological examination* (including balance testing) is normal.
3. *Cognitive testing* (computerised and/or pencil-and-paper) has returned to baseline or age-appropriate norms.

helping the athlete return at the appropriate time that does not compromise the athlete's health or performance.

At all participation levels (professional, elite, community/recreational), an athlete who is diagnosed with concussion should *not* be permitted to return to sport on the day the concussion is sustained. All athletes diagnosed with concussion should undergo serial clinical evaluations in the days following the injury.

Athletes participating at the elite level, who are removed from the playing arena with a suspected head injury, but are not diagnosed with concussion following a multifaceted, SCAT5-based assessment performed by an experienced clinician, may return to the game.

Even if no diagnosis of concussion has been made, athletes removed from sport with suspected concussion should undergo serial re-evaluations for up to 48 hours because of the possibility of delayed symptom onset. For the athlete who is diagnosed with concussion, monitoring should continue at regular intervals until the athlete is cleared to return to sport (box 2).

Athletes should follow a graded return to sport protocol before returning to unrestricted sport. This process typically takes 7 days, although there is variability in this time due to athlete-specific factors (eg, history, initial symptom severity, age) and this time interval is not evidenced-based. Expert consensus is that professional athletes supported by advanced care settings (as outlined below) may return on a slightly faster timeline than non-professional athletes, in cases where initial symptoms rapidly resolve, and a thorough medical and neuropsychological evaluation can be carried out by experienced providers. The athlete must have been exposed to high-intensity exercise before being cleared to participate in unrestricted sport.

Advanced care setting

This is an enhanced, well-resourced, clinical environment where individualised management of athletes can occur. An advanced care setting should be in place when contemplating a faster return to sport, and is the most appropriate environment for managing more complicated cases.

Key characteristics of an advanced care setting are access to:

- ▶ A medical doctor experienced in concussion management (sport medicine, physical medicine and rehabilitation, neurology or neurosurgery specialisations);
- ▶ Computerised and/or formal neuropsychological evaluation;
- ▶ Oculomotor and cervicovestibular evaluation and rehabilitation.

Where advanced care settings are not available, some sports advise compulsory, age-specific stand-down periods, where physical activity is limited to below the symptom threshold.

Specialist testing that may characterise advanced care settings
Neuropsychological testing is a useful adjunct to medical evaluation of concussion.

Formal neuropsychological testing conducted by a neuropsychologist is the gold standard:

- ▶ Where an accelerated return to sport (<7 days) is planned;
- ▶ In cases of delayed recovery (>1 month);
- ▶ In complex cases (eg, athletes with a history of multiple concussions);
- ▶ For athletes with pre-existing comorbidities (eg, psychological/psychiatric);
- ▶ In decisions regarding athlete retirement for the season or career.

If a specialist neuropsychologist is not available, supervised computerised testing batteries and additional expert clinical opinion should be employed for concussed athletes who return to sport in fewer than 7 days.

Important considerations for return to sport

A multidisciplinary, collaborative concussion management approach is encouraged, but the final return to sport decision should be made by the team clinician or an appropriately licensed healthcare professional.

Although evidence is limited, return to sport in child athletes, whose brains are still developing, should follow a more conservative approach than adults. A more conservative approach to return to sport should be taken with the paediatric population: children should not be permitted to return to unrestricted sport in fewer than 7 days, with several organisations mandating longer periods of time for this group.

On-line symptom and cognitive self-evaluation for readiness to return to sport by athletes is strongly discouraged. Athletes should not be taking medication to treat concussion-related symptoms when performing cognitive tests or returning to sport. Computerised neurocognitive test batteries (eg, CogState Sport, ImpACT) have cost implications, especially at community level, and should not take precedence over programmes to provide clinical care. Computerised batteries should not be used as the sole criterion for return to sport decision-making. Neurocognitive test batteries need to be interpreted as part of a comprehensive clinical evaluation—preferably by a neuropsychologist, when available.

Independence in the concussion management process

Many factors can complicate presentation, diagnosis and recovery from concussion, making additional medical opinions valuable in concussion management. In addition, television coverage and commentary of injuries in collision sport and the high profile of concussion as a public health issue, has placed medical management and return to sport decisions under increased scrutiny. Because of this, auditing of concussion diagnoses and management may be useful for quality assurance, training and medico-legal purposes.

Auditing strategies currently used in different collision sports include:

- ▶ *Independent, unaffiliated neurological consultants* who may assist with recognition of mechanisms of injury associated with potential concussion (live or on video), assist sideline concussion evaluation and follow-up on confirmed cases. The independent, unaffiliated consultant is often a neurosurgeon, neurologist, emergency medicine physician or rehabilitation medicine physician with expertise in managing traumatic brain injury.

Box 3 Six features of successful programmes across team collision sports

1. Providing community resources such as websites, online learning modules and access to concussion recognition tools. Examples include the CDC concussion courses and World Rugby's Player Welfare sites.
2. Training for medical personnel via online modules and courses, posters, booklets and smartphone applications.
3. Training for medical personnel, independent consultants, trainers and spotters through national workshops.
4. Education of match officials.
5. Education of television commentators.
6. Leadership from well-known players involved in public awareness campaigns.

- ▶ *Peer review* of team doctor decisions, case-by-case follow-up and referral to an expert panel for difficult cases.
- ▶ An *independent concussion consultant* to evaluate players in the days following injury.
- ▶ Using *match officials in the community* game who, when suspecting a possible concussion, may indicate removal from sport and direct the injured athlete to enter a process of formal medical evaluation and stand-down (eg, Blue Card system in rugby union).

Where independent medical personnel are used at the game, they may override team clinician's decisions and immediately and permanently remove a player from the field (eg, in rugby union). In other sports (eg, NFL), the independent unaffiliated neurological consultant is a second opinion, and the team clinician takes responsibility for final decisions regarding diagnosis and removal from sport. The team clinician is recognised as the person most knowledgeable about the athlete's baseline status. Team clinicians may also be in a more favourable position to recognise subtle signs of concussion such as a change in athlete behaviour or attitude that may not be detected by independent neurological consultants. The NFL recognises that on every medical team, one expert must make a final decision regarding athlete care—in the case of concussion, the team clinician is the expert. Team clinicians' decisions regarding return to sport should not be interfered with or challenged by non-medical personnel.

At the professional/elite levels, team clinicians typically have the final say in return to sport after concussion but may choose to avail themselves of consultant support for shared decision-making. In all settings (even where, theoretically, the independent clinician's opinion may be overriding), communication and collaboration among clinicians is strongly encouraged, and can be a benefit of the consultant system.

Practical implementation and translation of concussion management protocols

The updated (version 5) sports concussion tools published after The Fifth International Conference on Concussion in Sport provide the basis for clinical concussion screening and management. Prudent use of additional clinical evaluation and technology may improve accuracy, and validated translations of the tools are required to promote global application.

In community sport, the *CRT5* is the most appropriate tool for identification and removal from sport of athletes suspected of possible concussion or more serious brain injury since the *CRT5* highlights key symptoms, signs and 'red flags' indicating such

Box 4 Current areas of concussion research focus in team collision sports**Injury prevention**

- ▶ Implementation and evaluation of the effectiveness of rule changes
- ▶ Risk factors for concussion
- ▶ Genetic studies—apolipoprotein E, glial cell-derived neurotrophic factor, catechol-O-methyltransferase
- ▶ Energy absorbing artificial turf
- ▶ Energy absorbing helmet technology
- ▶ The role of tackling technique in reducing concussion risk

Screening and diagnosis

- ▶ Effectiveness of video assessment
- ▶ Sports Concussion Assessment Tool normative data
- ▶ Cross-cultural approaches to concussion assessment
- ▶ Effectiveness of baseline testing for improving diagnostic accuracy
- ▶ Sensitivity of the modified Balance Error Scoring System and tandem gait tests
- ▶ Additional assessment modalities, eg, reaction times, oculomotor, computerised and pencil-and-paper cognitive tests
- ▶ Role and accuracy of impact sensors
- ▶ Visual scanning assessment in the detection of concussion
- ▶ Diagnosis via visual-evoked potentials
- ▶ Blood biomarkers
- ▶ Imaging biomarkers
- ▶ Acute concussion triage using portable electroencephalogram
- ▶ New neurophysiology investigation tools
- ▶ The role of advanced imaging in concussion assessment

Treatment and management

- ▶ Active concussion rehabilitation
- ▶ Indications for targeted cervicovestibular and oculomotor rehabilitation
- ▶ Role of visual scanning assessment in return to sport
- ▶ Role of advanced imaging in monitoring concussion recovery
- ▶ Evaluation of return to sport assessments to determine readiness to compete following acute concussion

Mental and neurological health

- ▶ Relationships among mental health variables such as depression and post-traumatic stress (current and retired athletes) and concussion diagnosis, recovery from concussion and development of postconcussion syndrome
- ▶ Neurodegenerative diseases, vascular-related illnesses and mental health in former professional athletes
- ▶ Neuroimaging with retired athletes
- ▶ Brain bank projects

potential injuries. The *SCAT5* is the most appropriate instrument for use by healthcare professionals in the evaluation of the athlete who is suspected of having sustained a possible concussion. The benefits of these tools are that they are freely available and easy to use. The downside is that the *CRT5* and the *SCAT5* are relatively insensitive and non-specific instruments. Serial evaluation, further clinical assessments and a multidisciplinary approach improve diagnostic accuracy and decision making.

In professional sport, most collision sport codes perform baseline *SCAT5* assessments and computerised cognitive baseline tests, allowing for comparison of post head-impact event testing with preinjury values. Simulating identical conditions for

postinjury and baseline tests is important, including consideration for the test environment and athlete footwear.

The five-word recall lists form an important part of the assessment of verbal learning and memory. However, these lists are dated, familiar to many players and have a low ceiling effect.²⁰ Random rotation of the word lists and increasing the list to 10 words is recommended. The use of smartphone applications may improve efficiency and accuracy (eg, by randomising word lists and building in a 5 min time delay for word recall). Language barriers may limit the effectiveness of the word recall aspects of the SCAT5 as a global tool and appropriate, validated cultural adaptations of word lists is needed. Direct translation of the English words to other languages is inadequate, and will not reflect consistent assessment of verbal learning and memory across cultures. This is an area where co-operation between sports may be beneficial to increase the number of batteries of validated word lists in different languages.

Balance testing incorporates both the Balance Error Scoring System and tandem gait across most sporting codes. These tests may need to be adapted to suit the particular context of the sport (eg, testing the player while he or she is wearing ice skates or football boots). Additional sideline tools such as the King-Devick test²¹ or Visual Oculomotor Screen²² and others may increase diagnostic sensitivity, and are being researched in many sport codes.

Concussion awareness and education

Many concussions occur without a healthcare professional present. This makes public, athlete, parent and coach awareness an important aspect in initiating care. Concussion awareness and education efforts in collision sports can also influence policy development and cultural change in sports.

The USA pioneered the use of legislation²³ in all 50 states to enact concussion laws that protected youth sports activities. The three components of the state laws are (a) concussion education of the athletes and parents, (b) removal from sport in all suspected cases of concussion and no return to practice/training or competition until (c) a requisite clearance by a licensed healthcare provider with expertise in concussion.

There are universal challenges in reaching communities in remote areas and those with limited resources. Incorporating concussion guidelines into coaching material is a practice that has been successfully implemented in rugby union. Paramedics and clinicians who work in sporting communities should be familiar with the CRT5 and the SCAT5. Other healthcare providers, especially primary care and emergency care physicians, may need additional education and training.

In rural/remote areas, and communities with reduced access to medical support, sporting codes should be more directive in terms of concussion management. This may include mandating specific absolute and relative rest times, and graduated return to sport timeframes. Similarly, standardised management criteria should be more conservative and directive for younger athletes, and in situations where access to appropriately trained healthcare professionals is limited. Additionally, efforts to train medical professionals ranging from nurses, physician assistants and emergency medical technicians become more critical in these environments with a paucity of concussion experts.

Examples of where collision sports have successfully improved concussion education and awareness are shown in box 3 and box 4.

Current and future research

Concussion in team collision sports is an area of firm research focus. Research is currently being conducted in concussion injury

prevention, diagnosis, treatment and management, and mental health (box 4). Implementing research projects and data sharing is of common interest. To foster game-changing research, there is a need for co-operation among sporting codes, universities and government agencies. Providing feedback on research outcomes to athletes is also a priority.

SUMMARY

Due to the concussion rates associated with collision sports, each of these sports at all participation levels should strive for as comprehensive a clinical support system as possible, within resource and location constraints. Where concussion expertise is limited, management guidelines should be more rigid, and return to sport timeframes more conservative. Training additional ancillary medical personnel is also an urgent priority in these contexts. Where clinical support meets advanced care setting standards, concussion management and return to sport may become more individualised.

The CRT5 and SCAT5 form the basis of concussion identification and assessment in all sports. Widespread use could be improved by professional sports leading in the development of multiple language versions of these tools. Sports without interchange or temporary substitution rules may be compromising player care and should consider instituting rule changes rather than adapting player evaluation to a limited on-field assessment. At least 10 min should be allocated for an off-field evaluation in a distraction-free environment.

Ongoing awareness, education and training is essential for successful implementation of concussion management protocols. Athletes, coaches, officials, medical and paramedical personnel should receive ongoing hands-on and remote training using a range of written materials and 'on-line' modules. Extending concussion care knowledge to healthcare professionals such as nurses, emergency medical technicians, primary care and emergency medicine physicians is a priority.

Professional and elite sports organisations must continue to share information and collaborate to implement new protocols. Communication and collaboration is paramount for protecting our patients, our athletes.

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and CLA documented each delegates' input at the meeting. CLA formatted and proofread the paper. All other authors presented and spoke on behalf of their codes at the meeting, submitted written contributions to the paper and assisted with editing.

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