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## On-field identification and management of Concussion

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## INTRODUCTION

The sport of rugby union (hereinafter called 'rugby') is one of the most popular team sports globally due to a variety of benefits that the sport offers its participants <sup>(23)</sup>. However, rugby is also associated with a higher risk of injury to the player <sup>(23)</sup>. Of all rugby-related time-loss injuries (those necessitating missed training or match time), concussion is one of the most common injuries and is estimated to occur, on average, once every 6 matches or 4.7 concussions per 1000 player match hours at adult/senior men's rugby 15's level <sup>(9)</sup>.

The prevention of injury exists on a temporal continuum: from *primary* prevention on the one end to *tertiary* prevention on the other<sup>(20)</sup>. With respect to concussion, *primary* prevention refers to preventing the original injury from occurring, which is typically difficult in any sphere of injury prevention including sport <sup>(20)</sup>. *Secondary* prevention refers to management of the injury: from the point of when it initially occurs all the way through to a safe return to normal activity or match play <sup>(20)</sup>. *Tertiary* prevention is on the other end of the prevention continuum and is specific to the management of long-term injuries and disabilities, and therefore is not relevant to this review on concussion <sup>(20)</sup>.

It is estimated that only half of all concussions are reported by contact sport participants (including rugby) for various reasons. Amongst the reasons the player does not consider the injury to be serious enough, and fear of being left out of the team <sup>(7, 11)</sup>. Thus, unlike other common time-loss rugby injuries, such as ligament ruptures which are physically limiting and prevent the player from participating further in the game, concussion has an 'invisible' nature. Therefore concussion identification requires the active involvement of players, coaches, referees, medical support staff and parents or spouses to intervene where applicable <sup>(11)</sup>.

Furthermore, concussed players do not always follow the correct return-to-play guidelines (available at <http://boksmart.sarugby.co.za/content/concussion>) before returning to sport <sup>(2, 5)</sup>, This places the injured player at risk of developing long-lasting or permanent symptoms (in extreme cases) <sup>(5, 19)</sup>.

Therefore, the unique nature of concussion in rugby, which has been associated with sub-optimal *secondary prevention*, warrants further investigation into what is considered “best practice” for on-field identification and management of concussion.

The specific topic of this review is therefore ‘*On field identification and management of a Concussion*’.

## **METHODS**

The following databases were initially searched on the 18 September 2014 and re-checked before final editing: Medline (PubMed) and ClinicalKey. Owing to this rapidly evolving field, only articles for the last five years were considered for Pubmed using the following search strategies: “Brain concussion” (MeSH term for ‘concussion’) and “Post-concussion syndrome” (MeSH term for symptoms post-concussive event) and “Sports” (MeSH heading) and the following MeSH terms: “Diagnosis”, “Signs and Symptoms” or “therapy” (MeSH subheading). Systematic reviews, Guidelines and Patient information were considered. In all of these, the latest version of the Consensus Statement for Concussion in Sport <sup>(9, 19)</sup> and World Rugby guidelines for concussion for the general public <sup>(1, 19)</sup> were used as a point of reference. For ClinicalKey, the most recent revision of FirstConsult (formerly MedConsult) and Patient Education articles on “concussion” were consulted. Any supplementary information that these articles referred to (such as SCAT3) were also included.

## **RESULTS**

The described search strategy on PubMed yielded eight systematic reviews, one “FirstConsult” (physician information) article <sup>(14)</sup>, and four patient guidelines. The four guidelines were from the following sources: International Rugby Board (IRB) <sup>(1)</sup> which is now called “World Rugby”, *ClinicalKey* <sup>(15)</sup>, Center for Disease Control and Prevention (CDC) <sup>(3)</sup>, and Journal of American Medical Association (JAMA) <sup>(21)</sup>.

Of these 13 sources, four <sup>(1, 13, 15, 19)</sup> specifically described an “action plan” for on-field or “side-line” evaluation and management of concussion or suspected concussions.

## **Leaving no concussion unreported**

The first issue with concussion management in contact sports (including rugby) is that of under-reporting by players.

Concussion may not be as obvious an injury to players and spectators as other common musculoskeletal injuries such as a medial collateral ligament injury <sup>(11, 23)</sup>. If a concussed player is allowed to continue playing, the risk for sustaining a further concussion with more severe or prolonged symptoms is greatly increased.

In an attempt to reduce under-reporting of concussions in American Football, it has been suggested that wearable technology could provide more objective data to make these decisions <sup>(11)</sup>, however, this is not a realistic option for amateur rugby, particularly played within South Africa.

Given the importance of identifying all concussions, it is critical that those watching the game and especially coaches, referees, players, family members or spouses, and medical support (including first aid) assume some level of responsibility for identifying suspected concussions in those players that they are watching or playing rugby with <sup>(1)</sup>. Thus, concussion awareness and education is critical for all stakeholders involved in rugby <sup>(12)</sup>.

## **Pre-empting Concussion for improved on-field identification**

In South Africa, the compulsory BokSmart biennial rugby safety course provides concussion education as well as pocket Concussion Guides for all attending coaches and referees <sup>(22)</sup>. For all other stakeholders, the BokSmart ([www.boksmart.com](http://www.boksmart.com)) and World Rugby ([www.worldrugby.org](http://www.worldrugby.org)) websites provide additional education and general concussion information. Another particularly useful resource is World Rugby's "Pocket Concussion Recognition Tool" available on the BokSmart website (<http://images.supersport.com/Pocket%20CRT.pdf>). Similar education in New Zealand has been associated with a reduction in concussion complications <sup>(10)</sup>.

However, with a historically low reporting rate, it is expected that greater awareness and education among rugby stakeholders will in fact initially *increase*, and not decrease concussion rates <sup>(6, 11, 18)</sup>. Should this increase in rate occur, as some reports have already found <sup>(4)</sup>, it should be considered a success of education and awareness interventions in improving secondary prevention (including better reporting), rather than a failure of primary prevention interventions in not reducing concussions.

Besides these education interventions, it is critical that every rugby playing facility is adequately prepared for handling players suspected of sustaining concussions <sup>(19)</sup>. This preparation involves, but should not be limited to:

1. The establishment of a concussion management protocol: *Considering how suspected players are going to be identified and by whom,*
2. Provisions, facilities, legislation in place to assess players on and off the field: *Even if this necessitates policy and rule changes*
3. A medical team who are up-to-date on the most recent concussion management protocols and literature: *In charge of assessing the player and in setting up a functional clinical network, including hospitals, who can manage them appropriately*
4. The establishment of a concussion register: *Using the medical team, with up to date protocols, to keep a register of all concussed players, and to oversee and monitor their recovery and progress throughout the graduated return-to-play process*

### **Concussion on-field identification**

A concussion may be caused by direct or indirect (e.g. “whiplash”) trauma to the brain <sup>(1, 19)</sup>. Those potentially more susceptible to sustaining a concussion include, but are not limited to: children and adolescents; players who participate in contact sports (rugby, hockey, soccer), combat sports (boxing and martial arts), riding sports (horses, bikes, motorcycles); and players who have had a previous concussion <sup>(1, 13, 15, 19)</sup>. It is imperative that concussions are properly recognised and treated as early as possible <sup>(15)</sup>.

If a direct or indirect head trauma was not directly observed, any one of the following signs could indicate a potential concussion\* <sup>(1)</sup>:

1. Dazed, blank or vacant look
2. Loss of consciousness<sup>^</sup>
3. Fit/convulsion/seizure<sup>^</sup>
4. Lying motionless on the ground<sup>^</sup> or slow in returning to feet
5. Unsteady or any balance issues or a loss of co-ordination
6. Confused or a lack of awareness of surrounding events
7. Grabbing or clutching of the head
8. More emotional or irritable than normal.

\*For a more comprehensive list of signs and symptoms associated with concussion, go to:

<http://boksmart.sarugby.co.za/content/concussion>

<sup>^</sup> In these instances, it is important to consider that the player may have a concomitant neck injury and should therefore only be removed by a medical professional with spinal care training <sup>(1)</sup>

### **Sideline Concussion assessment tools**

The player with a suspected concussion should be removed from play and be assessed by a medically trained person who has specifically been trained in the evaluation and management of concussion <sup>(12)</sup>.

The American Society for Sports Medicine position statement for concussion in sport <sup>(12)</sup> states that history, balance testing and cognitive function should all be assessed, while the Consensus statement for Concussion in Sport <sup>(19)</sup> suggests that testing of the latter (cognitive function) is most important. With any clinical test, it is important to consider the sensitivity (correctly diagnosing those that *have* the condition) and specificity (correctly excluding those who *do NOT have* the condition) of the tool. In light of the dangers in allowing a player with a missed concussion to continue playing, it might make more sense to rather focus on sensitivity in the context of concussion.

For assessing cognitive function, the Consensus Statement for Concussion in Sport <sup>(19)</sup> recommends the SCAT3 (<http://bjsm.bmj.com/content/47/5/259.full.pdf>), which should be administered by medical professionals. The SCAT3 includes brief versions of Maddocks' questions (e.g. "What half is it now?" or "Who scored last in this match?") and Standard Assessment of Concussion (SAC) questions (e.g. "What day is it today?" and asking the player to say the months of the year in reverse-order).

*If no medical professional is available to perform the assessment*, then the Consensus Statement for Concussion in Sport <sup>(19)</sup> and World Rugby <sup>(1)</sup> suggest focussing on two of the SCAT3 components:

1. Visible signs and symptoms
2. Maddocks' questions.

These two assessments are packaged as a freely available, pocket-sized resource (<http://bjsm.bmj.com/content/47/5/267.full.pdf>) called the pocket Concussion Recognition Tool (CRT). The BokSmart on-field pocket Concussion Guide also includes these two components (<http://images.supersport.com/content/Concussion%20Guide%20V6%202015%20LR.pdf>).

Despite the Consensus Statement for Concussion in Sport advocating them as "practical and effective", it is important to note that the sensitivity and specificity of the SCAT3 and pocket Concussion recognition tools are yet to be assessed <sup>(12)</sup> (Table 1). Nonetheless, certain *individual* components of the SCAT3 and pocket CRT, specifically the SAC and 17-point symptom scores assessment, have been associated with the highest sensitivities recorded for concussion screening tools (94 and 89%, respectively) <sup>(12)</sup>.

The proclaimed "validity" of the Maddocks' questions should be interpreted with caution. There is only one study that has assessed the sensitivity of Maddocks' questions – this was performed in 1995 in 28 professional Australian Rules Football players (Table 1) <sup>(17)</sup>. With 14 subjects in each group, it is unlikely this study had the statistical power to ascertain whether Maddocks' questions are valid or not. Additionally, the fact that the lead author was testing the diagnosis tool that he had also developed, could constitute a conflict of interest.

Importantly, the Consensus Statement on Concussion in Sport stipulates that none of these brief cognitive tests replace a comprehensive neuropsychological test by a trained medical person, but they offer a screening tool for rapid assessment of a player suspected of having a concussion <sup>(19)</sup>.

Table 1. Sensitivity (ability to detect concussion) of various tools suggested for concussion on-field identification.

<b>Test (administration time)</b>	<b>Sensitivity % (diagnose concussions)</b>
<b>Symptom score (2-3 mins):</b>	
9-item	68
17-item	89
<b>Maddocks' questions (&lt;1 min)</b>	32-75
<b>SAC (5 mins)</b>	80-94
<b>BESS (5 mins)</b>	34
<b>Modified BESS (2-3 mins)</b>	NOT KNOWN
<b>SAC + BESS (10 mins)</b>	NOT KNOWN
<b>NFL Sideline concussion assessment tool</b>	NOT KNOWN
<b>Pocket Concussion Recognition Tool (5 mins)</b>	NOT KNOWN
<b>SCAT 3 (8—10 mins)</b>	NOT KNOWN
<b>BokSmart pocket Concussion Guide</b>	NOT KNOWN
<b>King-Devick (2 mins)</b>	NOT KNOWN

BESS – Balance Error Scoring System, SAC – Standard Assessment of Concussion, NFL – National Football League, SCAT – Standard Concussion Assessment Tool

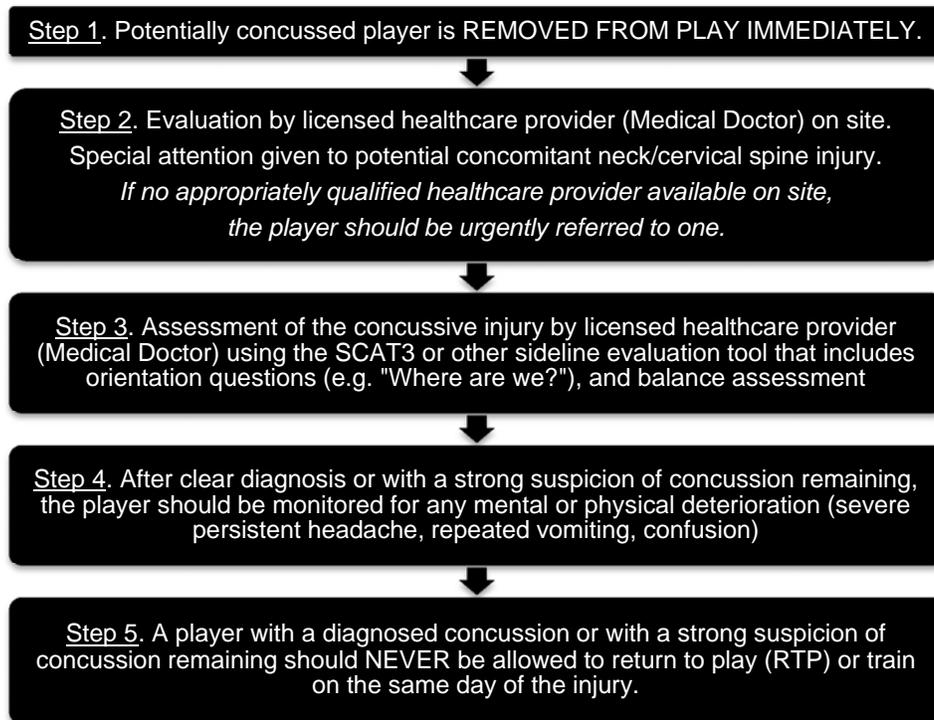
In terms of assessing balance, the Balance Error Scoring System (BESS) is recommended by the American Medical Society's position statement, although it appears to be more useful in assessing those who are not concussed than those who are <sup>(12)</sup>. However, this test does not appear to be particularly sensitive as empirical evidence suggests this assessment misses about two-thirds (66%) of concussions (Table 1) <sup>(12)</sup>.

Recently, the King-Devick test, a rapid eye movement test that was designed to detect oculomotor inefficiencies, has shown promising results in detecting concussions in MMA, boxers and rugby union and league players <sup>(8, 16)</sup>. However, as the authors who have done most of the testing of the King-Devick test in rugby state: "...there have been no longitudinal studies to assess the reliability, validity or generalizability of the King-Devick test, nor has it been tested across various age groups." As a result this test has not yet been endorsed by the Consensus Statement for Concussion in Sport <sup>(19)</sup> and World Rugby <sup>(1)</sup>.

Despite the lack of empirical evidence supporting the sensitivity of the discussed concussion assessments for both medical (SCAT3, and tests of which it is comprised) and for non-medical people (pocket CRT), this should not deter their prescribed use. These tools are all endorsed by both the Consensus Statement for Concussion in Sport <sup>(19)</sup> and World Rugby <sup>(1)</sup> and therefore constitute current best-practice in the game. However, it should be noted that these recommendations might change over time: for example with more research, the King-Devick test might be included in future consensus or guideline documents.

### **On-field Concussion Management**

In contrast to the equivocal literature on concussion sideline assessment tools, there is substantial consensus on the management once a player is suspected to have sustained a concussion. Once this suspicion of a concussion has occurred (through either of the recommended methods), a medical professional, trained in concussion management, should immediately implement the Five Step On-Field management procedure outlined in Figure 1. This diagram presents a summary of the four resources identified for this particular research question <sup>(1, 13, 15, 19)</sup>.



**Figure 1. Five step course of action for managing a player with a confirmed concussion or suspected concussion (1, 13, 15, 19).**

### Step 1

The World Rugby guidelines for the general public <sup>(1)</sup> and the American Medical Society for Sports Medicine (AMSSM) position statement <sup>(13)</sup> specifically state that the concussed or potentially concussed player should immediately be removed from play and then be evaluated by a healthcare provider. The wording of the consensus statement was more ambiguous on this point and the *ClinicalKey* patient guidelines <sup>(15)</sup> did not have a temporal reference to the potentially concussive event. Therefore, as two of the four sources explicitly stated that the player should be immediately removed from play, this has been included in Step 1.

## Step 2

Only the AMSSM position statement <sup>(13)</sup> specifically stated that the licensed healthcare provider (Medical Doctor) should be trained in the evaluation and management of concussion. While this is probably an important addition, it was not mentioned by any of the other three sources. Similarly, only the consensus statement <sup>(19)</sup> made mention of the fact that the healthcare provider's evaluation should be made "in a timely manner". However, both the consensus statement <sup>(19)</sup> and World Rugby's guidelines <sup>(1)</sup> made specific reference to the careful consideration of neck/cervical spinal injuries in concussed or potentially concussed players.

## Step 3

The Consensus Statement for Concussion in Sport <sup>(19)</sup> and World Rugby recommend that the SCAT3 (medical professional) or pocket CRT (non-medical person) are used to assess the concussion. Although the clinimetric properties have been debated in this article (Sideline concussion assessment tools), these tools represent current best-practice and should therefore be used as prescribed.

## Step 4

All resources except for the *ClinicalKey* patient guideline <sup>(15)</sup> suggested that the concussed player should be monitored after the injury. The amount of time after the injury was different for each source: the World Rugby guidelines <sup>(1)</sup> state a minimum of 24 hours, the consensus statement states "in the initial few hours after the injury" and the AMSSM position statement <sup>(13)</sup> does not specify a time. The specific signs and symptoms to be aware of differ depending on the resource consulted.

## Step 5

All resources except for the *ClinicalKey* patient guideline <sup>(15)</sup> explicitly state that a player with a diagnosed concussion is not able to return to play or train on the same day. The *ClinicalKey* patient guideline <sup>(15)</sup> states that return to play was a controversial subject in general and that it should be guided by the healthcare provider managing the injury.

## DISCUSSION

The main finding from this review was that the identification and reporting of the initial concussion is more of a challenge and topic for scientific debate than the management of the injury *per se* <sup>(7, 11, 18)</sup>. While alternate options have been suggested for American Football, the consensus for improving this under-reporting in rugby appears to be through education interventions and raising awareness in both medical professionals and stakeholders (coaches, referees, players, parents and spouses) <sup>(7, 11, 18)</sup>. The BokSmart compulsory biennial rugby safety course for coaches and referees is an example of an intervention that aims to educate coaches and referees on all aspects of concussion, including identification <sup>(22)</sup>. Additionally, the BokSmart website ([www.boksmart.com](http://www.boksmart.com)) provides freely available educational information as well as useful tools for identifying those players suspected of having a concussion. World Rugby has similar resources: <http://playerwelfare.worldrugby.org/concussion>.

While some authors debate the sensitivity of side line concussion tools in diagnosing concussions, the SCAT3 (for medical professionals) and pocket CRT (for non-medical professionals) are recommended by both the Consensus Statement for Concussion in Sport <sup>(19)</sup> and World Rugby <sup>(1)</sup>.

In contrast to the strategies to improve concussion reporting, there was substantial consensus on the management of a concussion once identified. The only major discrepancy is with the AMSSM position statement <sup>(13)</sup> that specifically states that the “licensed healthcare provider (Medical Doctor)” who assesses the potentially concussed player must be trained in concussion management (Step 1). While this may be a valid point, it is not mentioned in the consensus statement for concussions in sport <sup>(19)</sup> or World Rugby’s guidelines for concussion for the general public <sup>(1)</sup>. However this is probably due to the fact that World Rugby’s guidelines were based on the consensus statement <sup>(19)</sup>. Nonetheless, as the *ClinicalKey* patient guidelines did not provide any information on these points of disagreement and because this review was ultimately investigated with rugby union in mind, the findings of the AMSSM position statement <sup>(13)</sup> were weighted with less importance.

In conclusion, the on-field identification and management of concussion needs to be improved in rugby. Reporting can be improved through greater education and awareness in stakeholders, and in the use of side line concussion assessment tools. For sideline concussion assessments, the SCAT3 and pocket CRT should be used by medical and non-medical professionals, respectively, where possible. Once identified, the facility needs to have measures in place to optimally manage the player, as described in this review.

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