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When is it time to “call it quits” after concussion?”

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INTRODUCTION

Rugby union ('rugby') is one of the most popular team sports globally. Over five million male and female participants take part in the sport annually across 117 countries and five continents ^(7, 15). Rugby is classified as a collision sport that has substantial physical demands on the player, along with frequent exposure to contact situations ⁽¹⁵⁾. As a result, rugby players have a higher probability of incurring an injury than participants in non-collision sports ⁽¹⁵⁾. These injuries include concussion; time-loss injuries to the central/peripheral nervous system is the third most frequent injury type after muscle-tendon and joint-ligament injuries ⁽¹⁵⁾. A recent systematic review estimated rugby-related concussion rates to be 4.7 per 1000 match hours at adult/senior men's rugby 15's level ⁽⁷⁾. This equates to approximately one concussion every 6 matches.

Despite the relative frequency of concussions, there is variable knowledge of the optimal treatment required for this injury, resulting in the most recent consensus statement on concussion in sport focusing on "knowledge transfer" strategies ⁽¹³⁾. In a study of tackle football ⁽¹²⁾, which has similar concussion rates to rugby ⁽¹⁾, the authors discovered that parents could not accurately identify the symptoms of concussion. This was despite the fact that the majority (90%) of these tackle football parents reported having received some form of information on concussion ⁽¹²⁾. This lack of optimal knowledge transfer may extend to clinicians who are commonly required to treat concussion ⁽⁵⁾.

The specific question for this review was "When is it time to "call it quits" after 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 of post-concussive events) 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 ⁽¹³⁾ and World Rugby (formerly known as the International Rugby Board) guidelines for concussion for the general public ⁽²⁾ 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 terms, revealed eight systematic reviews on PubMed. Additionally there was one “FirstConsult” (physician information) article ⁽¹⁰⁾, and four patient guidelines. The four guidelines were from the following sources: World Rugby (WR) ⁽²⁾, *ClinicalKey* ⁽¹¹⁾, Center for Disease Control and Prevention (CDC) ⁽⁴⁾, and Journal of American Medical Association (JAMA) ⁽¹⁴⁾.

Unfortunately, none of the PubMed systematic reviews specifically answered the stated research question. This is because it requires long-term epidemiological studies to answer the specified research question. Such studies have not yet been published. Furthermore, the American Medical Society for Sports Medicine (AMSSM) position statement ⁽⁹⁾ declares that *“There are no evidence-based guidelines for disqualifying/retiring an athlete from sport after concussion. Each case should be carefully deliberated and an individualised approach to determining qualification taken.”*

Despite this lack of original research and evidence-based guidelines, there is some scientific information on chronic effects of concussion from which one could draw some conclusions for the purposes of the present review.

Chronic effects of concussion

One of the most significant short-term effects of concussion is increased risk of another concussion ^(1, 9). The increased risk of a second concussion is postulated to result from the slowed reaction times following an acute concussion ⁽⁹⁾.

The most concerning postulated long-term effects of repeated concussions can be summarised as “cognitive dysfunction” and the related signs/symptoms: depression, dementia and other neurodegenerative disorders ^(3, 9). This “cognitive dysfunction” includes the condition called chronic traumatic encephalopathy (CTE). However, the exact link between prior concussion and cognitive dysfunction is yet to be clearly established specifically pertaining to rugby^(3, 8, 9, 16).

Nevertheless the CTE discussion and resulting medico-legal debates surrounding contact sports have highlighted the importance of identifying players who should consider retirement from contact sport due to a potential increased risk of permanent cognitive and/or physical repercussions.

Furthermore, it is understood that the response to a concussion is highly individualised ^(6, 9, 13) making it even more difficult to provide an objective indication of when to retire from a particular sport.

In the best interests of the player’s longevity and welfare, Doolan and colleagues ⁽⁶⁾ suggest that a player’s sports physician (or Medical Doctor) should involve the player in the decision as to when they should stop playing. Furthermore, they have provided guidelines for when a player should consider terminating their season or terminating their career prematurely based on the number of concussions sustained and the signs and symptoms associated with the concussion(s) (Table 1).

Table 1. Suggestion to sports physicians for career-ending or season-ending concussions, based on any combination of number of concussions, signs or symptoms, by Doolan et al. ⁽⁶⁾.

	Number of concussions	Signs	Symptoms
Season-ending	>2 concussions in one season; >1 <i>severe</i> concussion in a season	Clinically-relevant imaging abnormality	Prolonged post-concussive symptoms; decreased athletic/academic performance
Career-ending	>2 <i>severe</i> concussions; decreased threshold for subsequent concussions	Pathologic abnormality (Chiari malformation, intracranial haemorrhage, clinically-relevant imaging abnormality)	Diminished academic performance or cognitive abilities; persistent post-concussion syndrome; any symptoms similar to Chronic Traumatic Encephalopathy

According to Doolan and colleagues ⁽⁶⁾, the licensed healthcare provider, (Medical Doctor in the South African context), could consider ending a player’s season where they have any combination of the indicators featured in Table 1 such as three or more concussions in one season and clinically-relevant imaging abnormalities.

Similarly, these authors suggest that once a player has experienced any combination of the indicators for ‘career-ending’ concussions, such as three or more severe concussions and pathological abnormalities, that the Medical Doctor should consider ending the player’s career.

Unfortunately, these authors do not provide a definition for a “severe” concussion, so the signs and symptoms in Table 1 may provide a more pragmatic clinical reference point. Also, because these authors stipulate that the treatment needs to be individualised and that most of the mentioned indicators describe a change, these signs and symptoms may only be pragmatically useful to a Medical Doctor if they have experience of the player at “baseline” or before the player experienced the concussions.

This is even more critical when eliminating potential co-existing medical conditions that have signs or symptoms similar to those of prolonged concussion symptoms. As a result, these guidelines probably err on the side of conservative, although the authors do not state this. Furthermore, the particular review is relatively “old” as it was published prior to the latest Consensus Statement for concussion.

However, in the “real world” setting, this is not a simple or clear-cut decision-making process. Therefore when a player reaches any combination of the indicators in Table 1, a more feasible approach might rather be for that player to be referred for multidisciplinary multi-modal clinical assessments within an Advanced Care setting.

In the absence of a Medical Doctor who has access to good baseline data for a player (prior to concussion), the expert opinion-based guidelines of WR ⁽²⁾ can be a good reference point for deciding whether or not a more conservative management approach and/or a more detailed clinical assessment is required.

For any player who has suffered a *second* concussion within a 12 month period, multiple concussions over a lifetime or prolonged recovery (>10 days) from concussion the player may need to be assessed by a multidisciplinary team with experience in managing sport-related concussions ⁽²⁾ within an Advanced Care setting.

World Rugby strongly recommends that all players seek the highest level of medical care available following concussion or suspected concussion. This highest level of concussion care is supplied in an advanced care setting and shall include at least all of the following:

- medical doctors with training and experience in recognising and managing concussion and suspected concussion; and
- access to brain imaging facilities and neuro-radiologists; and
- access to a multidisciplinary team of specialists including neurologists, neurosurgeons, neuropsychologists, neurocognitive testing, balance and vestibular rehabilitation therapists.

Following this assessment, a sustained period of rest from all collision sport should be prescribed and further decisions regarding the player’s end of season or retirement can be made over time with serial follow-up investigations, medical assessments and through direct consultation with the player.

Other potential evaluations or assessments that could indicate “It’s time to call it quits after Concussion”

Radiological imaging

For *routine* concussions, the Consensus Statement for Concussion in Sport ⁽¹³⁾ does not recommend any radiological imaging investigations as standard practice. However, of all radiological imaging techniques, the functional MRI (fMRI) is the best validated for indicating symptom severity and recovery. Although brain CT or MR brain scans are not validated for symptom recovery, they should certainly be considered in immediate management of concussion if any of the following are present: prolonged loss of consciousness, focal neurological deficit (speech, hearing, sight problems) or worsening symptoms (worsening headache, vomiting, balance issues). Moreover, in the case of multiple concussions (as outlined in Table 1), these radiological imaging techniques (fMRI, CT and MR scans) should also be considered as part of the multidisciplinary approach described ⁽⁶⁾.

Neurophysiological (NP) evaluation

Although the Consensus Statement for Concussion in Sport ⁽¹³⁾ doesn’t suggest NP for routine evaluations, as these tests assess cognitive function, they may be useful for difficult or prolonged cases. As all players are required to return to normal cognitive function before returning to play, should a NP assessment indicate that a player has not regained normal cognitive function, they should be precluded from returning to play ⁽¹³⁾. Although the NP assessment requires a comparison to baseline to assess “normal” function – normative data is available if baseline testing is absent for a particular player ⁽⁶⁾. Importantly, the Consensus Statement for Concussion in Sport ⁽¹³⁾ emphasises the importance of the Medical Doctor overseeing the player’s concussion management, and not the NP assessor, thereby allowing interpretation of the NP results within the clinical context of the specific player involved.

Similarly, to radiological imaging, multiple concussions to the same player (Table 1) should also warrant NP testing as part of the prescribed multidisciplinary approach, as long as the overall management is overseen by the Medical Doctor in charge of that player ⁽⁶⁾.

Exercise Stress Testing

The latest Consensus Statement for Concussion in Sport ⁽¹³⁾ only recommends Balance Error Scoring System (BESS) testing for assessing the motor component of a player’s recovery, particularly if balance abnormalities were present during the immediate assessment of the injury.

Although not recommended by the Consensus Statement for Concussion in Sport ⁽¹³⁾, the fMRI response (described previously) to a YMCA bike test offers promise of an additional investigation in future ⁽¹⁵⁾. The YMCA bike test is a submaximal (<70% of age-derived maximum heart rate), ramped protocol with increasing resistance. A study that compared males and females who were concussed while participating in ice hockey, soccer and rugby, to age-matched controls, found noticeable fMRI differences. However, it should be noted that

the concussed players in this study ⁽¹⁵⁾ were *asymptomatic* prior to the fMRI and YMCA stress test and therefore these players might not be considered difficult or prolonged recovery cases. Furthermore, more high level evidence is required before this would become a recommended investigation by the Consensus Statement for Concussion in Sport ⁽¹³⁾.

Biochemical investigations

Investigations that include genetic markers such as ApoE or Tau polymerase have produced equivocal results and are therefore not currently recommended by the Consensus Statement for Concussion in Sport ⁽¹³⁾.

DISCUSSION

The main finding from this review was, that while there were guidelines for when to ‘call it quits’ from one group, the realistic implementation of these guidelines for a Medical Doctor would require an established history with the player prior to them sustaining a concussion. In the absence of this baseline history, a physician may have to rely more on a multi-disciplinary investigation and management approach.

Importantly, a player with multiple concussions (Table 1) should be handled with extra care and by a multidisciplinary team that is overseen by a Medical Doctor ^(6, 13). Investigations that should be considered for this player with multiple concussions include: radiological imaging (but specifically fMRI), balance testing (such as the BESS) and Neuropsychological Testing (with reference to normative data if no baseline data are available). Decisions on return to play should be made in consultation with the overseeing Medical Doctor, the player, parent, spouse (if applicable) and coach ⁽⁶⁾. The medical doctor should consider terminating the player’s season if the player experiences any prolonged post-concussion symptoms or decreased athletic or academic performance following a concussion and should do this in consultation with a multidisciplinary team.

As with any other injury, concussed players are at risk of both short- and long-term effects as a result of this initial acute event. The short-term effects include physical, cognitive, emotional and sleep disturbances and, as might be expected for any injury, an increased risk of sustaining a recurrent injury ^(1, 6). The risk of this short-term effect should be minimised as long as the appropriate medical management is implemented and the age-appropriate return-to-play processes are adequately followed ⁽⁶⁾. However, no player, regardless of the sport, should be subjected to the risk of long-term or permanent effects from concussions. These long-term effects can be summarised as ‘complications’ ⁽¹⁰⁾ which include any of a constellation of cognitive or physical signs.

Although these conclusions lack sufficient original research at this point, it would be best for Medical Doctors to err on the side of caution with concussions and specifically multiple concussions to the same player, particularly when a potential long-term risk is permanent cognitive dysfunction.

As much as these guidelines may seek to increase the threshold of safety for players, the complex and variable nature of concussion necessitates a repeated and multifaceted analysis. A team of clinicians including sports physicians, neurologists, neurosurgeons, radiologists and neuropsychologists, and balance and vestibular rehabilitation therapists may need to be consulted to help with potential season-ending or permanent retirement decisions, which must ultimately put the players' welfare first.

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