Infographic. New Zealand Rugby's concussion management pathway

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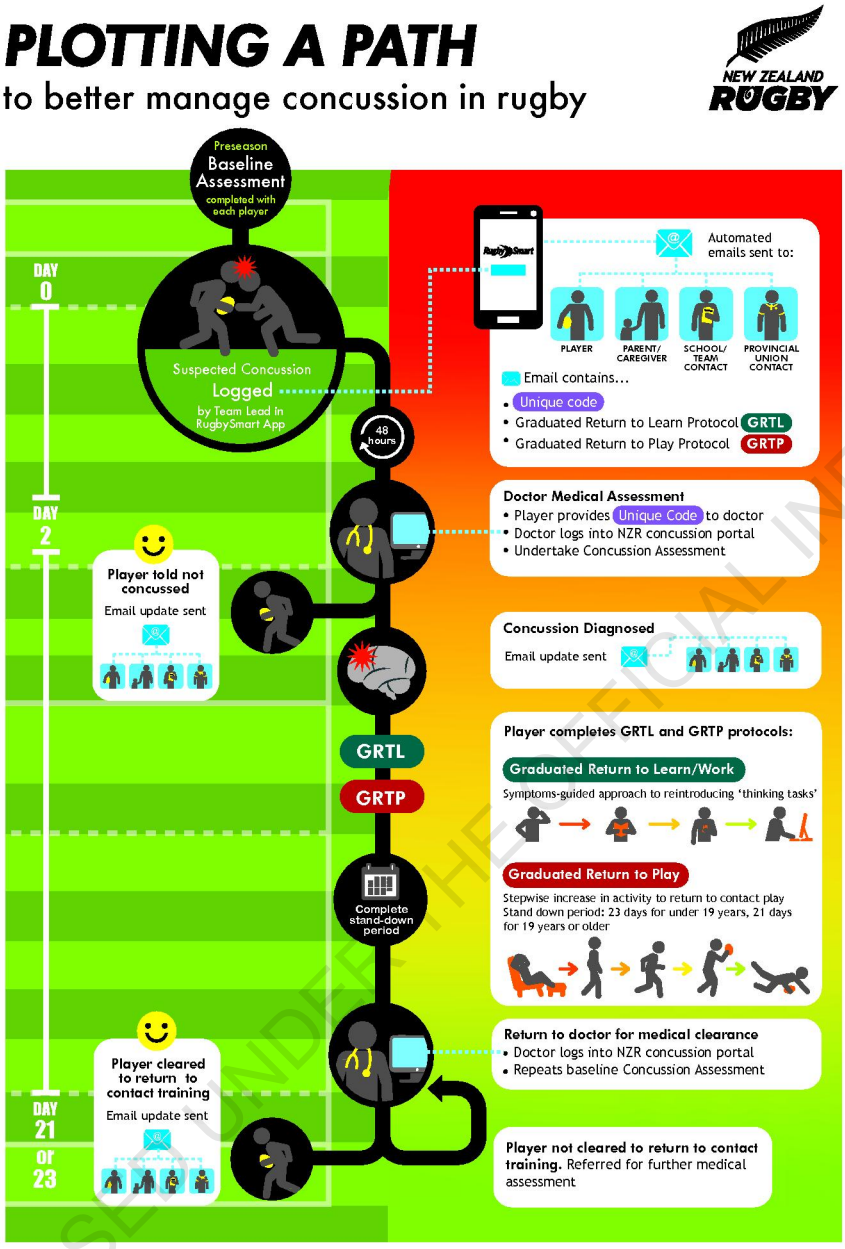

Concussions in rugby union (rugby) impact not only player welfare but parental and players' decisions around participation, a concern for rugby administrators around the world.[1 2] To ensure player welfare, World Rugby has developed concussion management recommendations (http://playerwelfare.worldrugby.org/concussion)[3]; however, the practical application and enforcement of these recommendations presents a challenge.[4 5] To address this challenge, New Zealand Rugby (NZR) as part of a National Concussion Initiative (infographic 1) developed a concussion management pathway (CMP) that considers the various stakeholders involved in the management of concussion as well as ways to support improved concussion management at the community level. The NZR CMP includes a Concussion Management Phone Application (App) and a web-based Concussion Portal for medical practitioners. The App allows the team lead (eg, physiotherapist, manager and parent) to complete the modified child SCAT5 baseline assessment during preseason and then log suspected concussions in the App as they occur during training or match play. The Concussion Portal allows medical practitioners to view players' baseline scores, provides guidance for diagnosis and medical clearance, and contains NZR regulations pertaining to concussion recognition, management, and graduated return to play (RTP) and graduated return to learn guidelines. The NZR CMP includes the following steps: (1) initial player concussion baseline testing performed using the App; (2) logging of a suspected concussion on the App; (3) App generated automated concussion email notifications that are sent to the player, their parents/caregivers, coaches, school/club and provincial union; (4) the notifications sent to the player and parents/caregivers contain a unique identifier code that will enable the doctor to access that player's baseline concussion score through the Concussion Portal; (5) clinical concussion diagnosis made by the medical doctor; (6) email notifications sent out to identified stakeholders; (7) appropriate RTP and medical clearance and (8) notifications that the player has been medically cleared sent to identified stakeholders. The NZR CMP has undergone extensive pilot work and consultation with the wider rugby community and is currently being trialled in several regions throughout NZ prior to the planned national rollout. The strength of the CMP is that it not only facilitates concussion recognition, diagnosis and management but also involves a network of community rugby stakeholders.[5] The purpose of the CMP is to close the loop between suspected concussion recognition and RTP following medical clearance through the use of technology to provide information to the relevant stakeholders at the appropriate time points to ensure player welfare.

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Original Research

Less Than Half of Patients Recover Within 2 Weeks of Injury After a Sports-Related Mild Traumatic Brain Injury: A 2-Year Prospective Study

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Abstract

Objective: To describe clinical recovery time and factors that might impact on recovery after a sports-related mild traumatic brain injury (SR-mTBI; concussion). **Design:** Prospective cohort study (level IV evidence). **Setting:** New Zealand Sports Concussion Clinic. **Participants:** Eight hundred twenty-two patients presenting within 14 days of a SR-mTBI/concussion over a 2-year period. **Main Outcome Measures:** Clinical recovery measured as number of days after injury. **Interventions Methods:** Participants were assessed and managed using a standardized protocol consisting of relative rest followed by controlled cognitive and physical loading. A reassessment was performed 14 days after injury with initiation of an active rehabilitation program consisting of a subsymptom threshold exercise program ± cervicovestibular rehabilitation (if required) for participants who remained symptomatic. Participants were then assessed every 2 weeks until clinical recovery. **Results:** A total of 594 participants were eligible for analysis (mean age 20.2 ± 8.7 years, 77% males) and were grouped into 3 age cohorts: children (≤12 years), adolescents (13-18 years), and adults (≥19 years). Forty-five percent of participants showed clinical recovery within 14 days of injury, 77% by 4 weeks after injury, and 96% by 8 weeks after injury. There was no significant difference in recovery time between age groups. Prolonged recovery was more common in females ($P = 0.001$), participants with "concussion modifiers" ($P = 0.001$), and with increased time between injury and the initial appointment ($P = 0.003$). **Conclusions:** This study challenges current perceptions that most people with a SR-mTBI (concussion) recover within 10 to 14 days and that age is a determinant of recovery rate. Active rehabilitation results in high recovery rates after SR-mTBI.

Key Words: sports-related concussion, sports-related mTBI, recovery, rehabilitation

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INTRODUCTION

Since 2001, the concussion in sport group (CISG) has met regularly to debate and define best practice relating to the assessment and management of sport-related concussion (SRC).[1] At the conclusion of each meeting, an international consensus statement is produced and published. This document is an important guide for clinicians and has been integrated into this study.

Until recently, CISG statements have stressed the importance of cognitive and physical rest until symptom resolution, widely reported to occur in most people within 7 to 10 days.[2–4] The most recent consensus statement reported the marked change in direction that SRC management had taken in the intervening 4 years.[5] It highlighted the limited evidence to support rest and recommended that this was kept to a brief period of 24 to 48 hours. After this period, patients are encouraged to become more active with potential treatment options including subsymptom threshold exercise (SSTE) programs, vestibular and cervical therapies, and targeted cognitive behavioral therapy approaches. Adoption of active management strategies for patients with a SRC has been internationally accepted,[6,7] with trials confirming the safety of such interventions.[8,9] A recent systematic review[10] reporting on the approach to treatment and management of persistent postconcussive symptoms found only 25 studies for inclusion, highlighting the relatively limited data available. This review included only 3 RCTs, whereas the remainder were level IV evidence cross-sectional studies, historical cohorts, and case series ranging from 6 to 128 patients.

The consensus statements have widely reported that 80% to 90% of patients show symptom resolution over a short time period of 7 to 10 days and that children and adolescents may

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require longer recovery periods.[3,4] The evidence for both of these assertions is limited to referencing an earlier consensus statement that states simple concussions are the most common form of injury and resolve without complication within 7 to 10 days, with no data or references given in support.[2] Despite this lack of evidence, these figures continue to be quoted even in recent guidelines.[11,12] Estimated recovery times, especially for adults, remain vague even in the most recent consensus statement, which states "it is reasonable to conclude that the large majority of injured athletes recover, from a clinical perspective, within the first month after injury." The reliance upon a clinical assessment, and in particular a patient's reported symptoms, as a measure of recovery does have some limitations. For example, it is well known that symptom report is not an effective proxy for concussion diagnosis or treatment. Asymptomatic individuals can have impairments, whereas those who have impairments may report no symptoms.[13] In the absence of a gold standard test for SRC however, current diagnostic criteria rely heavily on these clinical findings. Given that there is increasing concern about the impact that SRC may have, we need to be clear about recovery times and the impact possible treatment options have on this.

Although the CISG have endorsed the label SRC, the Center for Disease Control and Prevention has recently suggested that SRC may be better termed as SR mild traumatic brain injury (SR-mTBI)[14] due to the belief that this better reflects the potential impact of the condition. As a result, the term SR-mTBI will be used in this article.

This prospective cohort, from a single community-based sports concussion clinic, will report outcomes on nearly 600 patients seen over a 2 year period, with the aim of quantifying the length of clinical recovery and identifying factors that may be associated with slower recovery. All patients followed a standardized assessment and an active rehabilitation protocol in line with current best practice methods.

METHODS

Design and Setting

A 2-year prospective observational cohort study (level of evidence IV) was conducted in a dedicated fully funded community–based sports concussion clinic in Auckland, New Zealand. Participants attending the clinic were seen by a sports medicine doctor, exercise physiologist, and a physiotherapist with postgraduate vestibular therapy qualifications.

Patient and Public Involvement

Patients and public were not involved in any way in our work.

Definition

Sports-related mTBI is defined as a traumatic brain injury in line with the latest CISG consensus statements.[5]

Participants and Recruitment

Participants consisted of all people who presented between January 2017 and December 2018 with a possible SR-mTBI. Participants were either referred by general practitioners, physiotherapists, other allied health professionals, school nurses, local and public hospital emergency clinics, team coaches and sports clubs, or could self-refer. Exclusion criteria were people presenting after 14 days after injury and those with a non–SR-mTBI, the latter due to external public funding restrictions. Analysis was limited to participants who achieved clinical recovery as defined below. Participants excluded from analysis (Figure 1) were those not diagnosed with a SR-mTBI during their initial assessment, those who had incomplete clinical data despite being clinically recovered, those who had not yet completed 8 weeks of the model of care (and therefore remained under care), or those referred on as requiring more multidisciplinary care due to persistent symptoms 8 weeks after injury (eg, occupational therapist, psychologist, and neuropsychologist). Ethical approval was obtained via the Accident Compensation Corporation New Zealand Ethics Committee. Informed consent and/or age appropriate assent was obtained from each participant.

Assessment Protocol

Participants followed a standardized assessment and management protocol in line with the latest CISG Statement.[5] The initial consultation involved an injury history, previous

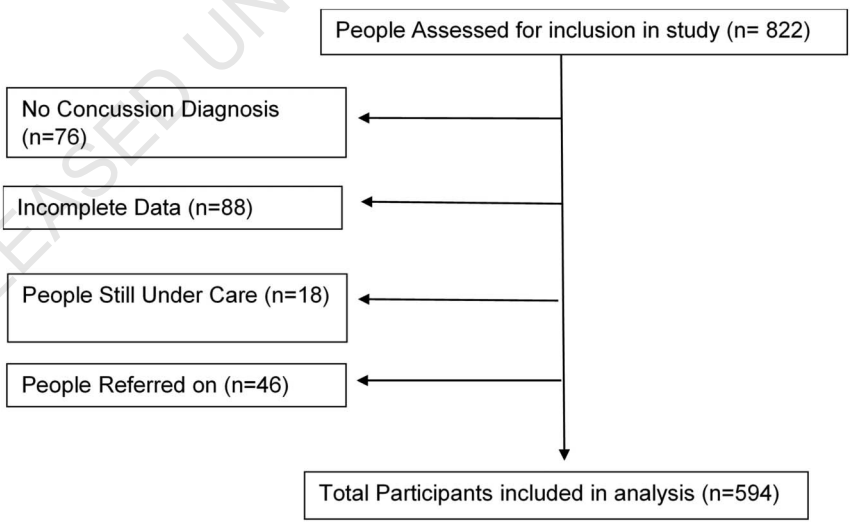

Figure 1. Participant flow within the study.

SR-mTBI history, and an assessment of any "concussion modifiers" (patient-reported preinjury history of migraine or mental health issues).[5] An age-appropriate SCAT5 assessment was performed. Physical examination to screen for more serious pathology such as occult intracranial pathology and cervical spine instability was performed. This involved a cranial nerve assessment (I-XII) and a targeted peripheral neurological assessment of reflexes and motor and sensory function if dictated by patient presentation. A vestibular assessment via the vestibulo-oculomotor screening tool was conducted.[15,16] The cervical spine was assessed using active range of movement with flexion, extension, and lateral rotation. Additional tests assessed cervical alignment to assess cervical joint position error, assessing the patient's ability to relocate their head to a neutral position with less than 5 degrees of error, whereas the cervical flexion head rotation test assessed upper cervical movement.[17,18] Palpation of the cervical spine for tenderness with trigger point reproduction of headache symptoms completed the cervical spine assessment. Autonomic dysfunction was assessed using only supine and standing blood pressure measurements at 1 and 3 minutes. Follow-up consultations involved repeating the SCAT5 symptom evaluation and a review of previous abnormal physical findings.

Management Protocol

After their initial consult, participants were given written and verbal advice consistent with the latest CISG statement.[5] A 24- to 48-hour period of rest followed by controlled cognitive and physical loading, guided by symptom exacerbation, was prescribed to encourage activity, with emphasis on patient education at this initial consult. Participants were re-assessed at day 14 after injury. At this stage, they were defined as being "clinically recovered" or "still symptomatic." If a participant was deemed to have clinically recovered, they commenced a graduated return to a sport (GRTS) program with re-evaluation before return to full training.[5] Those who were "still symptomatic" underwent graded aerobic exercise testing using the Buffalo Concussion Treadmill Test with subsequent development of a SSTE program.[7,19] Adjunct cervical or vestibular physiotherapy was prescribed if appropriate based on relevant clinical signs either at this reassessment or at the initial consultation.[20] Participants were assessed once every 2 weeks until clinical recovery. At this point, they commenced the same GRTS protocol. This standardized model of care and rehabilitation is outlined in **Appendix 1** (see **Supplemental Digital Content 1**, http://links.lww.com/JSM/A219).

Definition of Clinical Recovery

Participants were defined as achieving clinical recovery when both their SCAT5 symptom score and symptom severity score were <5 for males and <6 for females. This distinction is based on normative data for the general population.[21] Participants were also required to have resolution of any previous abnormal clinical examination findings and "normal" exercise tolerance. Normal exercise tolerance was defined as being asymptomatic when exercising at 85% to 90% of predicted heart rate if measured or return to the participants' usual preinjury exercise levels. Length of recovery was a reported measure by participant recall defined as the number of days between injury and the time the participant reached clinical recovery. As participants were assessed once every 2 weeks, this figure permits accuracy for the time intervals measured against (within 2 weeks; 2-4 weeks; 4-8 weeks; and $\geq$8 weeks).

Statistical Analysis

Participant characteristics were assessed for differences according to age groups: children ($\leq$12 years), adolescents (13-18 years), and adults ($\geq$19 years). A Kruskal–Wallis test was used for continuous variables due to their skewed distributions, including days until initial appointment, number of previous concussions, days until asymptomatic, and number of follow-up visits. A χ^2 test was used to assess potential differences in gender, sport type, and concussion modifier by the age group. Length of recovery (measured by time to clinical recovery; within 2, 2-4, 4-8, or $\geq$8 weeks) was summarized overall and within each age group. Multiple linear regression was used to determine mutually adjusted associations of participant characteristics with length of recovery, measured by the number of days to clinical recovery. A natural log transformation was used for the outcome due to a skewed distribution, with the model including all factors that showed an unadjusted association with the outcome. Because the outcome is log-transformed, we calculated the average percentage differences in the length of recovery for each variable in the model using the exponential of the regression coefficients.[22] Statistical analyses were conducted using Stata version 15.1.

RESULTS

All 822 participants presenting with a possible SR-mTBI during the study period from January 2017 to December 2018 were assessed for inclusion in this study. A total of 594 (77% males) with age range 7 to 64 years (average age 20.2 years) were included in the analysis as presented in Table 1. Figure 1 shows that 28% of people presenting were not eligible for inclusion, with 39% (n = 88) of these being ineligible due to incomplete or missing information in relevant data fields rather than loss to follow-up. Five percent of participants were referred on as they did not achieve clinical recovery under this model of care and were assessed as requiring additional input. Those not included in the analysis due to incomplete data (n = 88) did not differ significantly from those eligible in terms of any of the characteristics described in Table 1.

The average number of days until the initial consultation was 8.7 days after injury, whilst Rugby Union accounted for 54% of the all consultations. The $\leq$12 years age group had a significantly lower proportion of females ($P = 0.008$) than the older age groups. There was also an association between age group and the number of previous concussions, with older participants having had more previous concussions ($P = 0.0001$). There were no statistically significant differences by the age group in terms of days until initial assessment, days until clinical recovery, number of follow-up visits, sport type, or presence of a concussion modifier ($P > 0.05$ for all comparisons). Only 45% of participants across all age groups had clinical recovery within 2 weeks after injury, increasing to 77% by 4 weeks, and 94% by 8 weeks (Table 2). All participants included in the analysis achieved clinical recovery within the study period.

TABLE 1. Descriptive Summary of Eligible Participants by the Age Group

	Age ≤12 years (n = 45)	Age 13-18 years (n = 290)	Age ≥19 years (n = 259)	All (n = 594)
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Age (yr)	10.7 ± 1.4	15.8 ± 1.6	26.8 ± 9.0	20.2 ± 8.5
Days until initial assessment	8.4 ± 4.5	8.2 ± 4.9	9.2 ± 7.1	8.7 ± 6.0
No. of previous concussions	0.4 ± 0.9	0.7 ± 1.1	1.2 ± 1.8	0.9 ± 1.5
Days until asymptomatic	16.2 ± 14.6	18.3 ± 13.3	21.6 ± 22.3	19.5 ± 18.0
No. of follow-up visits	1.7 ± 1.1	1.9 ± 1.2	1.8 ± 1.5	1.9 ± 1.3
	N (%)	N (%)	N (%)	N (%)
Sex				
Female	2 (4.4)	70 (24.1)	66 (25.5	138 (23.2)
Male	43 (95.6)	220 (75.9)	193 (74.5)	456 (76.8)
Sport				
Rugby union	25 (55.6)	149 (51.4)	148 (57.1)	322 (54.2)
Rugby league	1 (2.2)	21 (7.2)	15 (5.8)	37 (6.2)
Football (soccer)	7 (15.6)	38 (13.1)	24 (9.3)	69 (11.6)
Field hockey	1 (2.2)	9 (3.1)	4 (1.5)	14 (2.4)
Netball	0 (0.0)	6 (2.1)	4 (1.5)	10 (1.7)
Other	11 (24.4)	67 (23.1)	64 (24.7)	142 (23.9)
Concussion modifier				
Not present	44 (97.8)	246 (85.1)	219 (84.9)	509 (86.0)
Present	1 (2.2)	43 (14.9)	39 (15.1)	83 (14.0)

In unadjusted analysis, there was no association between the length of recovery and the number of previous concussions ($P = 0.92$) or age group ($P = 0.36$). A multiple linear regression model showed that females, those with injuries from sports other than Rugby Union, those with a concussion modifier, and those with more time between their injury and the initial appointment had significantly longer recovery times (Table 3). On average, the number of days until clinical recovery was 43% (exp (0.36) = 1.43, or a 43% increase) longer for females, whereas those with modifiers had a 48% longer recovery time. For each additional day between injury and the initial appointment, there was an increase in the average recovery time; for a 7-day increase in time to the initial appointment, we could expect an approximate 15% increase in the number of days until clinical recovery ($\exp(0.02 \times 7) = 1.15$).

A total of 5% of participants received cervical rehabilitation, 28% received vestibular rehabilitation, and 10% received combined cervicovestibular rehabilitation as part of their individualized management. A smaller proportion of children (≤12 years) required cervicovestibular rehabilitation (n = 4, 17%) than adolescents (13-18 years, n = 69, 42%) or adults (≥19 years, n = 63, 50%). Vestibular rehabilitation alone or in combination with cervical rehabilitation was more likely in adults (44% of patients) than younger age groups.

DISCUSSION

The current study shows that less than half of those presenting acutely with a SR-mTBI show clinical recovery within 14 days and therefore, at best, may be cleared to return to play at 21 days following the accepted GRTS program. This rate of recovery is slower than described in previous CISG and other position statements.[3,4,11,12] It is only at 28 days postinjury does this figure rise to be comparable with the recovery rates quoted in these publications. Those participants referred on are not represented in this figure and if accounted for would only strengthen our case by adding to the number who had not recovered within certain time frames.

As previously stated, recovery rates of 80% to 90% within 7 to 10 days appeared first in the third consensus statement on concussion in sport[4] referenced to the second consensus statement that has no supportive data.[2] A review of references from this

TABLE 2. Recovery of all Patients by the Age Group, Measured as the Number of Weeks After Injury Until Asymptomatic

	No. of Days After injury Until Asymptomatic			
Age Group	**<2 wk**	**2-4 wk**	**4-8 wk**	**≥ 8 wk**
≤12 yrs	22 (48.9%)	16 (35.6%)	6 (13.3%)	1 (2.2%)
13-18 yrs	116 (40.0%)	117 (40.3%)	49 (16.9%)	8 (2.8%)
>18 yrs	130 (50.2%)	58 (22.4%)	46 (17.8%)	25 (9.6%)
All ages	268 (45.1%)	191 (32.2%)	101 (17.0%)	34 (5.7%)

TABLE 3. Multiple Linear Regression of Factors Associated With Length of Recovery, Measured by the Number of Days After Injury to Asymptomatic Status

Variable	Category/Unit	Coefficient (95% CI)	*P*
Sex	Male	Reference	
	Female	0.36 (0.15 to 0.57)	0.001
Sport	Rugby union	Reference	
	Rugby league	0.16 (−0.17 to 0.51)	0.339
	Football (soccer)	0.57 (0.30 to 0.83)	<0.001
	Other*	0.64 (0.44 to 0.86)	<0.001
Modifiers	No	Reference	
	Yes	0.39 (0.15 to 0.62)	0.001
Time from injury to initial appointment	Days	0.02 (0.01 to 0.03)	0.003

** Including hockey, netball, bike sports, water sports, snow sports, lacrosse, and combat sports such as martial arts and boxing.*

early consensus paper highlight only opinion pieces[23] or small cohort studies within single sports discussing concussion grading and postinjury symptomatology.[24,25] In fact, data within the second international conference on concussion in sport[2] cites a rugby league study showing that 50% of players still demonstrated impaired neurocognitive performance on testing 10 days after injury.[24] A systematic review has estimated the prevalence of prolonged recovery (defined as >14 days in adults and >28 days in children) to be between 10% and 30%, after SR-mTBI.[10] Unfortunately, only 25 studies met the inclusion criteria. These studies generally had relatively small sample sizes, (n = 6-128, mean age 20.1 years, duration of symptoms 10-226 days), were of relatively poor quality, and had an inconsistent definition of persistent symptoms. Outside sport, there are data supporting a more prolonged recovery time after mTBI. A 2-year multicenter retrospective electronic health record review analyzed the injury and treatment history of 1840 adolescent patients (10-17 years),[26] showing a similar duration of recovery as presented in the current study. In this study, 75% of patients were symptom-free or had returned to preinjury symptom levels 4 weeks after injury. Only 16% had recovered within the first week, whereas 6.7% remained symptomatic at 8 weeks. A large multicenter Canadian study also reported persistent symptoms at 4 weeks in 30% of patients.[27] We believe that our data may reflect the natural recovery timeline for those with a SR-mTBI and that recovery rates may be slower than previously reported. Given the uncertainty around the original statements, and increasing data suggesting that many people have a more prolonged recovery, more conservative recommendations may need to be made in future consensus statements.

The literature focuses on slower recovery times in younger patients.[3–5] Existing data compare adolescents with children[28] and high school athletes with collegiate athletes.[29] Interpreting these data is however difficult due to inconsistencies between study designs.[28] Age showed no significant association with recovery in our cohort, a finding consistent with another larger study.[30] Our results suggest that the natural recovery timeline for SR-mTBI is similar irrespective of age. It is possible that the current data may more accurately represent the true recovery trajectory for SR-mTBI, given that all participants, regardless of age or level of sport, followed a standardized treatment protocol including early active rehabilitation and equal access to medical resources, with similar recovery times across groups. Given these findings, we would suggest a more conservative approach across all age groups and not just younger groups.

Gender and "concussion modifiers" represent well-published risk factors for recovery,[5] and our results further support this. It is unclear why the Rugby Union seems to represent less risk of prolonged recovery compared with other sports. This might reflect a proactive system wide approach from within this sport, with education, clear advice, and early management, resulting in less overall morbidity.[31] It is also possible that this is due to an under-reporting of concussion symptoms and not true recovery among those who play rugby.[32] There are a number of other factors that might influence recovery. We have found a positive association between persistent symptoms and a higher initial symptom burden (SCAT5 symptom score/severity score) with this being the subject of another publication.[33]

This current study suggests that those who are seen more quickly after a SR-mTBI may have a faster recovery. This is consistent with existing data demonstrating that earlier assessment may reduce the severity of persistent symptoms and enhance recovery.[26,34] Many patients with a SR-mTBI do not appreciate the value of a medical assessment and do not present for an assessment until their symptoms fail to resolve. Others return to sport before their injury has resolved and are at an increased risk of a further SR-mTBI or other types of injury.[35] It is possible these attitudes and behaviors are partly driven by the perception that SR-mTBI is a self-limiting problem. The results of this study challenge this perception and illustrate a need for more education for those involved in sport.

STRENGTHS AND LIMITATIONS

The main strength of this study is in the prospectively collected data from a large sample of participants with a SR-mTBI. Participants were assessed and managed using a standardized, best practice model of care. We acknowledge that SR-mTBI may be a different clinical entity to mTBI sustained outside sport; hence, results may not be applicable to this group. The lack of a gold standard test and the reliance on symptom reporting will continue to be a limitation for all clinical research in this area. Our definition of clinical recovery allows participants to have some symptoms reflecting the nonspecific nature of symptom reporting. Mandatory use of the Buffalo Concussion Treadmill Test before the GRTS program may provide a more objective measure of physiological recovery, but the logistical nature of this is difficult to achieve outside of the research setting. Another potential limitation relates to the use of the SCAT5. This tool is a validated diagnostic support

tool designed for use on the sideline and was not designed for specific clinical setting use,[36] although use is widespread. The lack of baseline comparison neurocognitive scores is also a potential limitation. Further limitations relate to the discharge criteria used; although participants were followed up until their clearance to return to normal sporting activity, it is not clear whether they did this successfully or not. This methodology was used for logistical reasons and has been used in other papers.[20] There is the potential for selection bias in this study. Patients were able to self-refer, which could indicate higher motivation to return to sport but equally reflect patient fear or catastrophizing, both of which could influence recovery duration. Finally, the overall number of participants younger than 12 years is very small and does not permit any meaningful analysis. We continue to collect prospective data and now have a larger cohort of pediatric patients. In time, we are hoping to be able to publish some more meaningful data on this group in a separate paper. We believe that this will be more useful.

CONCLUSIONS

Recovery from a SR-mTBI is slower than previous international consensus statements have indicated. Less than half of all participants in this study recovered within 2 weeks after injury, and it is only at 28 days after injury do recovery rates match those quoted in these statements. This is irrespective of age with adults, adolescents, and children showing similar recovery rates within 2 weeks, by 4 weeks, and by 8 weeks after injury with best practice clinical care delivered across all age groups. Delay to presentation leads to delay in recovery with the message of early access to care needing to be mandated within individual sports.

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SCAT5©

SPORT CONCUSSION ASSESSMENT TOOL – 5TH EDITION

DEVELOPED BY THE CONCUSSION IN SPORT GROUP

FOR USE BY MEDICAL PROFESSIONALS ONLY

supported by

Patient details

Name: _____

DOB: _____

Address: _____

ID number: _____

Examiner: _____

Date of Injury: _____ Time: _____

WHAT IS THE SCAT5?

The SCAT5 is a standardized tool for evaluating concussions designed for use by physicians and licensed healthcare professionals[1]. The SCAT5 cannot be performed correctly in less than 10 minutes.

If you are not a physician or licensed healthcare professional, please use the Concussion Recognition Tool 5 (CRT5). The SCAT5 is to be used for evaluating athletes aged 13 years and older. For children aged 12 years or younger, please use the Child SCAT5.

Preseason SCAT5 baseline testing can be useful for interpreting post-injury test scores, but is not required for that purpose.Detailed instructions for use of the SCAT5 are provided on page 7. Please read through these instructions carefully before testing the athlete. Brief verbal instructions for each test are given in italics. The only equipment required for the tester is a watch or timer.

Recognise and Remove

A head impact by either a direct blow or indirect transmission of force can be associated with a serious and potentially fatal brain injury. If there are significant concerns, including any of the red flags listed in Box 1, then activation of emergency procedures and urgent transport to the nearest hospital should be arranged.

Key points

- Any athlete with suspected concussion should be REMOVED FROM PLAY, medically assessed and monitored for deterioration. No athlete diagnosed with concussion should be returned to play on the day of injury.
- If an athlete is suspected of having a concussion and medical personnel are not immediately available, the athlete should be referred to a medical facility for urgent assessment.
- Athletes with suspected concussion should not drink alcohol, use recreational drugs and should not drive a motor vehicle until cleared to do so by a medical professional.
- Concussion signs and symptoms evolve over time and it is important to consider repeat evaluation in the assessment of concussion.
- The diagnosis of a concussion is a clinical judgment, made by a medical professional. The SCAT5 should NOT be used by itself to make, or exclude, the diagnosis of concussion. An athlete may have a concussion even if their SCAT5 is "normal".

Remember:

- The basic principles of first aid (danger, response, airway, breathing, circulation) should be followed.
- Do not attempt to move the athlete (other than that required for airway management) unless trained to do so.
- Assessment for a spinal cord injury is a critical part of the initial on-field assessment.
- Do not remove a helmet or any other equipment unless trained to do so safely.

1

IMMEDIATE OR ON-FIELD ASSESSMENT

The following elements should be assessed for all athletes who are suspected of having a concussion prior to proceeding to the neurocognitive assessment and ideally should be done on-field after the first first aid / emergency care priorities are completed.

If any of the "Red Flags" or observable signs are noted after a direct or indirect blow to the head, the athlete should be immediately and safely removed from participation and evaluated by a physician or licensed healthcare professional.

Consideration of transportation to a medical facility should be at the discretion of the physician or licensed healthcare professional.

The GCS is important as a standard measure for all patients and can be done serially if necessary in the event of deterioration in conscious state. The Maddocks questions and cervical spine exam are critical steps of the immediate assessment; however, these do not need to be done serially.

Name: _____

DOB: _____

Address: _____

ID number: _____

Examiner: _____

Date: _____

STEP 1: RED FLAGS

RED FLAGS:

- **Neck pain or tenderness**
- **Double vision**
- **Weakness or tingling/ burning in arms or legs**
- **Severe or increasing headache**
- **Seizure or convulsion**
- **Loss of consciousness**
- **Deteriorating conscious state**
- **Vomiting**
- **Increasingly restless, agitated or combative**

STEP 2: OBSERVABLE SIGNS

Witnessed ☐ Observed on Video ☐

Lying motionless on the playing surface	Y	N
Balance / gait difficulties / motor incoordination: stumbling, slow / laboured movements	Y	N
Disorientation or confusion, or an inability to respond appropriately to questions	Y	N
Blank or vacant look	Y	N
Facial injury after head trauma	Y	N

STEP 3: MEMORY ASSESSMENT MADDOCKS QUESTIONS[2]

"I am going to ask you a few questions, please listen carefully and give your best effort. First, tell me what happened?"

Mark Y for correct answer / N for incorrect

What venue are we at today?	Y	N
Which half is it now?	Y	N
Who scored last in this match?	Y	N
What team did you play last week / game?	Y	N
Did your team win the last game?	Y	N

Note: Appropriate sport-specific questions may be substituted.

STEP 4: EXAMINATION GLASGOW COMA SCALE (GCS)[3]

Time of assessment			
Date of assessment			
Best eye response (E)			
No eye opening	1	1	1
Eye opening in response to pain	2	2	2
Eye opening to speech	3	3	3
Eyes opening spontaneously	4	4	4
Best verbal response (V)			
No verbal response	1	1	1
Incomprehensible sounds	2	2	2
Inappropriate words	3	3	3
Confused	4	4	4
Oriented	5	5	5
Best motor response (M)			
No motor response	1	1	1
Extension to pain	2	2	2
Abnormal flexion to pain	3	3	3
Flexion / Withdrawal to pain	4	4	4
Localizes to pain	5	5	5
Obeys commands	6	6	6
Glasgow Coma score (E + V + M)			

CERVICAL SPINE ASSESSMENT

Does the athlete report that their neck is pain free at rest?	Y	N
If there is NO neck pain at rest, does the athlete have a full range of ACTIVE pain free movement?	Y	N
Is the limb strength and sensation normal?	Y	N

In a patient who is not lucid or fully conscious, a cervical spine injury should be assumed until proven otherwise.

OFFICE OR OFF-FIELD ASSESSMENT

Please note that the neurocognitive assessment should be done in a distraction-free environment with the athlete in a resting state.

STEP 1: ATHLETE BACKGROUND

Sport / team / school: _____

Date / time of injury: _____

Years of education completed: _____

Age: _____

Gender: M / F / Other

Dominant hand: left / neither / right

How many diagnosed concussions has the athlete had in the past?: _____

When was the most recent concussion?: _____

How long was the recovery (time to being cleared to play) from the most recent concussion?: _____ (days)

Has the athlete ever been:

Hospitalized for a head injury?	Yes	No
Diagnosed / treated for headache disorder or migraines?	Yes	No
Diagnosed with a learning disability / dyslexia?	Yes	No
Diagnosed with ADD / ADHD?	Yes	No
Diagnosed with depression, anxiety or other psychiatric disorder?	Yes	No

Current medications? If yes, please list:

_____

_____

_____

_____

_____

_____

Name: _____

DOB: _____

Address: _____

ID number: _____

Examiner: _____

Date: _____

2

STEP 2: SYMPTOM EVALUATION

The athlete should be given the symptom form and asked to read this instruction paragraph out loud then complete the symptom scale. For the baseline assessment, the athlete should rate his/her symptoms based on how he/she typically feels and for the post injury assessment the athlete should rate their symptoms at this point in time.

Please Check: ☐ **Baseline** ☐ **Post-Injury**

Please hand the form to the athlete

	none	mild		moderate		severe	
Headache	0	1	2	3	4	5	6
"Pressure in head"	0	1	2	3	4	5	6
Neck Pain	0	1	2	3	4	5	6
Nausea or vomiting	0	1	2	3	4	5	6
Dizziness	0	1	2	3	4	5	6
Blurred vision	0	1	2	3	4	5	6
Balance problems	0	1	2	3	4	5	6
Sensitivity to light	0	1	2	3	4	5	6
Sensitivity to noise	0	1	2	3	4	5	6
Feeling slowed down	0	1	2	3	4	5	6
Feeling like "in a fog"	0	1	2	3	4	5	6
"Don't feel right"	0	1	2	3	4	5	6
Difficulty concentrating	0	1	2	3	4	5	6
Difficulty remembering	0	1	2	3	4	5	6
Fatigue or low energy	0	1	2	3	4	5	6
Confusion	0	1	2	3	4	5	6
Drowsiness	0	1	2	3	4	5	6
More emotional	0	1	2	3	4	5	6
Irritability	0	1	2	3	4	5	6
Sadness	0	1	2	3	4	5	6
Nervous or Anxious	0	1	2	3	4	5	6
Trouble falling asleep (if applicable)	0	1	2	3	4	5	6

Total number of symptoms:	of 22
Symptom severity score:	of 132
Do your symptoms get worse with physical activity?	Y N
Do your symptoms get worse with mental activity?	Y N
If 100% is feeling perfectly normal, what percent of normal do you feel?	

If not 100%, why?

_____

_____

_____

Please hand form back to examiner

3

STEP 3: COGNITIVE SCREENING

Standardised Assessment of Concussion (SAC)[4]

Name: _____

DOB: _____

Address: _____

ID number: _____

Examiner: _____

Date: _____

ORIENTATION

What month is it?	0	1
What is the date today?	0	1
What is the day of the week?	0	1
What year is it?	0	1
What time is it right now? (within 1 hour)	0	1
Orientation score		of 5

IMMEDIATE MEMORY

The Immediate Memory component can be completed using the traditional 5-word per trial list or optionally using 10-words per trial to minimise any ceiling effect. All 3 trials must be administered irrespective of the number correct on the first trial. Administer at the rate of one word per second.

Please choose EITHER the 5 or 10 word list groups and circle the specific word list chosen for this test.

I am going to test your memory. I will read you a list of words and when I am done, repeat back as many words as you can remember, in any order. For Trials 2 & 3: I am going to repeat the same list again. Repeat back as many words as you can remember in any order, even if you said the word before.

List	Alternate 5 word lists					Score (of 5) Trial 1	Trial 2	Trial 3
A	Finger	Penny	Blanket	Lemon	Insect			
B	Candle	Paper	Sugar	Sandwich	Wagon			
C	Baby	Monkey	Perfume	Sunset	Iron			
D	Elbow	Apple	Carpet	Saddle	Bubble			
E	Jacket	Arrow	Pepper	Cotton	Movie			
F	Dollar	Honey	Mirror	Saddle	Anchor			
					Immediate Memory Score			of 15
					Time that last trial was completed			

List	Alternate 10 word lists					Score (of 10) Trial 1	Trial 2	Trial 3
G	Finger Candle	Penny Paper	Blanket Sugar	Lemon Sandwich	Insect Wagon			
H	Baby Elbow	Monkey Apple	Perfume Carpet	Sunset Saddle	Iron Bubble			
I	Jacket Dollar	Arrow Honey	Pepper Mirror	Cotton Saddle	Movie Anchor			
					Immediate Memory Score			of 30
					Time that last trial was completed			

CONCENTRATION

DIGITS BACKWARDS

Please circle the Digit list chosen (A, B, C, D, E, F). Administer at the rate of one digit per second reading DOWN the selected column.

I am going to read a string of numbers and when I am done, you repeat them back to me in reverse order of how I read them to you. For example, if I say 7-1-9, you would say 9-1-7.

Concentration Number Lists (circle one)					
List A	List B	List C			
4-9-3	5-2-6	1-4-2	Y	N	0
6-2-9	4-1-5	6-5-8	Y	N	1
3-8-1-4	1-7-9-5	6-8-3-1	Y	N	0
3-2-7-9	4-9-6-8	3-4-8-1	Y	N	1
6-2-9-7-1	4-8-5-2-7	4-9-1-5-3	Y	N	0
1-5-2-8-6	6-1-8-4-3	6-8-2-5-1	Y	N	1
7-1-8-4-6-2	8-3-1-9-6-4	3-7-6-5-1-9	Y	N	0
5-3-9-1-4-8	7-2-4-8-5-6	9-2-6-5-1-4	Y	N	1
List D	List E	List F			
7-8-2	3-8-2	2-7-1	Y	N	0
9-2-6	5-1-8	4-7-9	Y	N	1
4-1-8-3	2-7-9-3	1-6-8-3	Y	N	0
9-7-2-3	2-1-6-9	3-9-2-4	Y	N	1
1-7-9-2-6	4-1-8-6-9	2-4-7-5-8	Y	N	0
4-1-7-5-2	9-4-1-7-5	8-3-9-6-4	Y	N	1
2-6-4-8-1-7	6-9-7-3-8-2	5-8-6-2-4-9	Y	N	0
8-4-1-9-3-5	4-2-7-9-3-8	3-1-7-8-2-6	Y	N	1
		Digits Score:			of 4

MONTHS IN REVERSE ORDER

Now tell me the months of the year in reverse order. Start with the last month and go backward. So you'll say December, November. Go ahead.

Dec - Nov - Oct - Sept - Aug - Jul - Jun - May - Apr - Mar - Feb - Jan	0 1
Months Score	of 1
Concentration Total Score (Digits + Months)	of 5

4

STEP 4: NEUROLOGICAL SCREEN

See the instruction sheet (page 7) for details of test administration and scoring of the tests.

Can the patient read aloud (e.g. symptom check-list) and follow instructions without difficulty?	Y	N
Does the patient have a full range of pain-free PASSIVE cervical spine movement?	Y	N
Without moving their head or neck, can the patient look side-to-side and up-and-down without double vision?	Y	N
Can the patient perform the finger nose coordination test normally?	Y	N
Can the patient perform tandem gait normally?	Y	N

BALANCE EXAMINATION

Modified Balance Error Scoring System (mBESS) testing[5]

Which foot was tested (i.e. which is the non-dominant foot) ☐ Left ☐ Right

Testing surface (hard floor, field, etc.) _____

Footwear (shoes, barefoot, braces, tape, etc.) _____

Condition	Errors
Double leg stance	of 10
Single leg stance (non-dominant foot)	of 10
Tandem stance (non-dominant foot at the back)	of 10
Total Errors	of 30

Name: _____

DOB: _____

Address: _____

ID number: _____

Examiner: _____

Date: _____

5

STEP 5: DELAYED RECALL:

The delayed recall should be performed after 5 minutes have elapsed since the end of the Immediate Recall section. Score 1 pt. for each correct response.

Do you remember that list of words I read a few times earlier? Tell me as many words from the list as you can remember in any order.

Time Started

Please record each word correctly recalled. Total score equals number of words recalled.

_____

_____

_____

Total number of words recalled accurately: of 5 or of 10

6

STEP 6: DECISION

	Date & time of assessment:		
Domain			
Symptom number (of 22)			
Symptom severity score (of 132)			
Orientation (of 5)			
Immediate memory	of 15 of 30	of 15 of 30	of 15 of 30
Concentration (of 5)			
Neuro exam	Normal Abnormal	Normal Abnormal	Normal Abnormal
Balance errors (of 30)			
Delayed Recall	of 5 of 10	of 5 of 10	of 5 of 10

Date and time of injury: _____

If the athlete is known to you prior to their injury, are they different from their usual self?

☐ **Yes** ☐ **No** ☐ **Unsure** ☐ **Not Applicable**

(If different, describe why in the clinical notes section)

Concussion Diagnosed?

☐ **Yes** ☐ **No** ☐ **Unsure** ☐ **Not Applicable**

If re-testing, has the athlete improved?

☐ **Yes** ☐ **No** ☐ **Unsure** ☐ **Not Applicable**

I am a physician or licensed healthcare professional and I have personally administered or supervised the administration of this SCAT5.

Signature: _____

Name: _____

Title: _____

Registration number (if applicable): _____

Date: _____

SCORING ON THE SCAT5 SHOULD NOT BE USED AS A STAND-ALONE METHOD TO DIAGNOSE CONCUSSION, MEASURE RECOVERY OR MAKE DECISIONS ABOUT AN ATHLETE'S READINESS TO RETURN TO COMPETITION AFTER CONCUSSION.

CLINICAL NOTES:

Name: _____

DOB: _____

Address: _____

ID number: _____

Examiner: _____

Date: _____

CONCUSSION INJURY ADVICE

(To be given to the person monitoring the concussed athlete)

This patient has received an injury to the head. A careful medical examination has been carried out and no sign of any serious complications has been found. Recovery time is variable across individuals and the patient will need monitoring for a further period by a responsible adult. Your treating physician will provide guidance as to this timeframe.

If you notice any change in behaviour, vomiting, worsening headache, double vision or excessive drowsiness, please telephone your doctor or the nearest hospital emergency department immediately.

Other important points:

Initial rest: Limit physical activity to routine daily activities (avoid exercise, training, sports) and limit activities such as school, work, and screen time to a level that does not worsen symptoms.

1) Avoid alcohol

2) Avoid prescription or non-prescription drugs without medical supervision. Specifically:

   a) Avoid sleeping tablets

   b) Do not use aspirin, anti-inflammatory medication or stronger pain medications such as narcotics

3) Do not drive until cleared by a healthcare professional.

4) Return to play/sport requires clearance by a healthcare professional.

Clinic phone number: _____

Patient's name: _____

Date / time of injury: _____

Date / time of medical review: _____

Healthcare Provider: _____

Contact details or stamp

INSTRUCTIONS

Words in *Italics* throughout the SCAT5 are the instructions given to the athlete by the clinician

Symptom Scale

The time frame for symptoms should be based on the type of test being administered. At baseline it is advantageous to assess how an athlete "typically" feels whereas during the acute/post-acute stage it is best to ask how the athlete feels at the time of testing.

The symptom scale should be completed by the athlete, not by the examiner. In situations where the symptom scale is being completed after exercise, it should be done in a resting state, generally by approximating his/her resting heart rate.

For total number of symptoms, maximum possible is 22 except immediately post injury, if sleep item is omitted, which then creates a maximum of 21.

For Symptom severity score, add all scores in table, maximum possible is 22 x 6 = 132, except immediately post injury if sleep item is omitted, which then creates a maximum of 21x6=126.

Immediate Memory

The Immediate Memory component can be completed using the traditional 5-word per trial list or, optionally, using 10-words per trial. The literature suggests that the Immediate Memory has a notable ceiling effect when a 5-word list is used. In settings where this ceiling is prominent, the examiner may wish to make the task more difficult by incorporating two 5–word groups for a total of 10 words per trial. In this case, the maximum score per trial is 10 with a total trial maximum of 30.

Choose one of the word lists (either 5 or 10). Then perform 3 trials of immediate memory using this list.

Complete all 3 trials regardless of score on previous trials.

"I am going to test your memory. I will read you a list of words and when I am done, repeat back as many words as you can remember, in any order." The words must be read at a rate of one word per second.

Trials 2 & 3 MUST be completed regardless of score on trial 1 & 2.

Trials 2 & 3:

"I am going to repeat the same list again. Repeat back as many words as you can remember in any order, even if you said the word before."

Score 1 pt. for each correct response. Total score equals sum across all 3 trials. Do NOT inform the athlete that delayed recall will be tested.

Concentration

Digits backward

Choose one column of digits from lists A, B, C, D, E or F and administer those digits as follows:

Say: *"I am going to read a string of numbers and when I am done, you repeat them back to me in reverse order of how I read them to you. For example, if I say 7-1-9, you would say 9-1-7."*

Begin with first 3 digit string.

If correct, circle "Y" for correct and go to next string length. If incorrect, circle "N" for the first string length and read trial 2 in the same string length. One point possible for each string length. Stop after incorrect on both trials (2 N's) in a string length. The digits should be read at the rate of one per second.

Months in reverse order

"Now tell me the months of the year in reverse order. Start with the last month and go backward. So you'll say December, November ... Go ahead"

1 pt. for entire sequence correct

Delayed Recall

The delayed recall should be performed after 5 minutes have elapsed since the end of the Immediate Recall section.

"Do you remember that list of words I read a few times earlier? Tell me as many words from the list as you can remember in any order."

Score 1 pt. for each correct response

Modified Balance Error Scoring System (mBESS)[5] testing

This balance testing is based on a modified version of the Balance Error Scoring System (BESS)[5]. A timing device is required for this testing.

Each of 20-second trial/stance is scored by counting the number of errors. The examiner will begin counting errors only after the athlete has assumed the proper start position. The modified BESS is calculated by adding one error point for each error during the three 20-second tests. The maximum number of errors for any single condition is 10. If the athlete commits multiple errors simultaneously, only one error is recorded but the athlete should quickly return to the testing position, and counting should resume once the athlete is set. Athletes that are unable to maintain the testing procedure for a minimum of five seconds at the start are assigned the highest possible score, ten, for that testing condition.

OPTION: For further assessment, the same 3 stances can be performed on a surface of medium density foam (e.g., approximately 50cm x 40cm x 6cm).

Balance testing – types of errors

1. Hands lifted off iliac crest
2. Opening eyes
3. Step, stumble, or fall
4. Moving hip into > 30 degrees abduction
5. Lifting forefoot or heel
6. Remaining out of test position > 5 sec

"I am now going to test your balance. Please take your shoes off (if applicable), roll up your pant legs above ankle (if applicable), and remove any ankle taping (if applicable). This test will consist of three twenty second tests with different stances."

(a) Double leg stance:

"The first stance is standing with your feet together with your hands on your hips and with your eyes closed. You should try to maintain stability in that position for 20 seconds. I will be counting the number of times you move out of this position. I will start timing when you are set and have closed your eyes."

(b) Single leg stance:

"If you were to kick a ball, which foot would you use? [This will be the dominant foot] *Now stand on your non-dominant foot. The dominant leg should be held in approximately 30 degrees of hip flexion and 45 degrees of knee flexion. Again, you should try to maintain stability for 20 seconds with your hands on your hips and your eyes closed. I will be counting the number of times you move out of this position. If you stumble out of this position, open your eyes and return to the start position and continue balancing. I will start timing when you are set and have closed your eyes."*

(c) Tandem stance:

"Now stand heel-to-toe with your non-dominant foot in back. Your weight should be evenly distributed across both feet. Again, you should try to maintain stability for 20 seconds with your hands on your hips and your eyes closed. I will be counting the number of times you move out of this position. If you stumble out of this position, open your eyes and return to the start position and continue balancing. I will start timing when you are set and have closed your eyes."

Tandem Gait

Participants are instructed to stand with their feet together behind a starting line (the test is best done with footwear removed). Then, they walk in a forward direction as quickly and as accurately as possible along a 38mm wide (sports tape), 3 metre line with an alternate foot heel-to-toe gait ensuring that they approximate their heel and toe on each step. Once they cross the end of the 3m line, they turn 180 degrees and return to the starting point using the same gait. Athletes fail the test if they step off the line, have a separation between their heel and toe, or if they touch or grab the examiner or an object.

Finger to Nose

"I am going to test your coordination now. Please sit comfortably on the chair with your eyes open and your arm (either right or left) outstretched (shoulder flexed to 90 degrees and elbow and fingers extended), pointing in front of you. When I give a start signal, I would like you to perform five successive finger to nose repetitions using your index finger to touch the tip of the nose, and then return to the starting position, as quickly and as accurately as possible."

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CONCUSSION INFORMATION

Any athlete suspected of having a concussion should be removed from play and seek medical evaluation.

Signs to watch for

Problems could arise over the first 24-48 hours. The athlete should not be left alone and must go to a hospital at once if they experience:

- Worsening headache
- Drowsiness or inability to be awakened
- Inability to recognize people or places
- Repeated vomiting
- Unusual behaviour or confusion or irritable
- Seizures (arms and legs jerk uncontrollably)
- Weakness or numbness in arms or legs
- Unsteadiness on their feet.
- Slurred speech

Consult your physician or licensed healthcare professional after a suspected concussion. Remember, it is better to be safe.

Rest & Rehabilitation

After a concussion, the athlete should have physical rest and relative cognitive rest for a few days to allow their symptoms to improve. In most cases, after no more than a few days of rest, the athlete should gradually increase their daily activity level as long as their symptoms do not worsen. Once the athlete is able to complete their usual daily activities without concussion-related symptoms, the second step of the return to play/sport progression can be started. The athlete should not return to play/sport until their concussion-related symptoms have resolved and the athlete has successfully returned to full school/learning activities.

When returning to play/sport, the athlete should follow a stepwise, **medically managed exercise progression, with increasing amounts of exercise.** For example:

Graduated Return to Sport Strategy

Exercise step	Functional exercise at each step	Goal of each step
1. Symptom-limited activity	Daily activities that do not provoke symptoms.	Gradual reintroduction of work/school activities.
2. Light aerobic exercise	Walking or stationary cycling at slow to medium pace. No resistance training.	Increase heart rate.
3. Sport-specific exercise	Running or skating drills. No head impact activities.	Add movement.
4. Non-contact training drills	Harder training drills, e.g., passing drills. May start progressive resistance training.	Exercise, coordination, and increased thinking.
5. Full contact practice	Following medical clearance, participate in normal training activities.	Restore confidence and assess functional skills by coaching staff.
6. Return to play/sport	Normal game play.	

In this example, it would be typical to have 24 hours (or longer) for each step of the progression. If any symptoms worsen while exercising, the athlete should go back to the previous step. Resistance training should be added only in the later stages (Stage 3 or 4 at the earliest).

Written clearance should be provided by a healthcare professional before return to play/sport as directed by local laws and regulations.

Graduated Return to School Strategy

Concussion may affect the ability to learn at school. The athlete may need to miss a few days of school after a concussion. When going back to school, some athletes may need to go back gradually and may need to have some changes made to their schedule so that concussion symptoms do not get worse. If a particular activity makes symptoms worse, then the athlete should stop that activity and rest until symptoms get better. To make sure that the athlete can get back to school without problems, it is important that the healthcare provider, parents, caregivers and teachers talk to each other so that everyone knows what the plan is for the athlete to go back to school.

Note: If mental activity does not cause any symptoms, the athlete may be able to skip step 2 and return to school part-time before doing school activities at home first.

Mental Activity	Activity at each step	Goal of each step
1. Daily activities that do not give the athlete symptoms	Typical activities that the athlete does during the day as long as they do not increase symptoms (e.g. reading, texting, screen time). Start with 5-15 minutes at a time and gradually build up.	Gradual return to typical activities.
2. School activities	Homework, reading or other cognitive activities outside of the classroom.	Increase tolerance to cognitive work.
3. Return to school part-time	Gradual introduction of school-work. May need to start with a partial school day or with increased breaks during the day.	Increase academic activities.
4. Return to school full-time	Gradually progress school activities until a full day can be tolerated.	Return to full academic activities and catch up on missed work.

If the athlete continues to have symptoms with mental activity, some other accomodations that can help with return to school may include:

- Starting school later, only going for half days, or going only to certain classes
- More time to finish assignments/tests
- Quiet room to finish assignments/tests
- Not going to noisy areas like the cafeteria, assembly halls, sporting events, music class, shop class, etc.
- Taking lots of breaks during class, homework, tests
- No more than one exam/day
- Shorter assignments
- Repetition/memory cues
- Use of a student helper/tutor
- Reassurance from teachers that the child will be supported while getting better

The athlete should not go back to sports until they are back to school/learning, without symptoms getting significantly worse and no longer needing any changes to their schedule.

AUT TRAUMATIC BRAIN INJURY NETWORK

Brain Injury Screening Tool (BIST)

A guide to traumatic brain injury assessment

The BIST was developed to be a brief tool for use on initial presentation after injury to guide health care pathway decision making and to monitor symptoms and recovery over time. Its purpose is to help guide the clinical assessment conversation by operationalising current international best practice guidelines.[1]

The BIST has been developed for health professionals working across primary and secondary health care and for sports and other contexts where traumatic brain injuries (TBI) can occur.

The BIST can facilitate clinical decision making through identification of people who are at low, medium or high risk of longer-term difficulties.

This tool should be used in addition to clinical judgment and other assessments such as the Vestibular/Oculomotor Motor Screening (VOMS), King-Devick or the Romberg's test. Additional questioning to add to the clinical picture is encouraged.

The first 9 questions in the BIST are designed to assist if there are clinical indicators that the person is at high risk of complications or poor recovery and requires hospital evaluation. The 15-item symptom scale is designed to assist in identifying patients at moderate risk of poor recovery who may benefit from early specialist treatment and low risk patients who are likely to recover well, supported within primary care.

Date of Injury:

Time of Injury:

Date of Consultation:

Age[1]:

Gender/Sex:

1. If over 65 years, socially isolated or living alone, consider referral to the Emergency Department.

Ethnicity:

If your answer is OTHER please specify:

1. Please tell me about what happened[2] (Observe for high risk indicators such as suspicion of skull fracture, focal neurological deficit, high speed, focal blunt trauma or fall from height (e.g. >5 stairs)

2. If high risk indicators present, consider referral to Emergency Department.

2. Did anyone with you at the time of the injury say anything else about what happened?

3. Have you been sick/vomited?[3]

Yes ◯ **No** ◯ a. If yes, how many times

3. If >1 vomiting episode, consider referral to Emergency Department.

4. Were you knocked out (or did you lose consciousness)?[4]

Yes ◯ **No** ◯ **Unknown** ◯ a. If yes, how long hrs mins

4. If loss of consciousness >brief, consider referral to Emergency Department.

5. Did you have a fit or seizure straight afterwards? E.g. go stiff or shake violently?[5]

Yes ◯ **No** ◯ **Unknown** ◯

5. If yes, consider referral to Emergency Department.

6. Are you feeling better, worse or about the same since the injury?[6]

Better ◯ **Worse** ◯ **About the same** ◯

6. If symptoms have worsened, consider referral to Emergency Department.

7. Have you hit your head or had a concussion/brain injury before ?[7]

Yes ◯ **No** ◯ a. If yes, how many times

b. when was the last injury?

7. If recent or unrecovered previous injury, consider referral to Emergency Department.
If recent injury but recovered the person may be moderate risk of poor recovery and early specialist input may be required. Consider referral to concussion service.

8. Are you currently taking any medications that thin the blood e.g. anti-coagulants? **Yes**[8] ◯ **No** ◯

8. If yes, consider referral to emergency department.

9. Have you ever experienced any difficulties with your mental health?

Yes[9] ◯ **No** ◯

9. If yes, the person may be at moderate risk of poor recovery and early specialist input may be required. Consider referral to concussion service.

Please ask the patient the following question.

Compared with before the accident, please rate how much you experience the following right now (at this point in time);

		Not at all	Mild (a little)			Moderate (quite bad)				Severe (very bad)		
		0	1	2	3	4	5	6	7	8	9	10
Physical	Headache (my head hurts)[10]											
	My neck hurts											
	I don't like bright lights											
	I don't like loud noises											
Total physical score (out of 40)												
Vestibular-ocular	I feel dizzy or like I could be sick											
	If I close my eyes, I feel like I am at sea											
	I have trouble with my eyesight (vision)											
	I feel clumsy											
Total vestibular score (out of 40)												
Cognitive	It takes me longer to think											
	I forget things											
	I get confused easily											
	I have trouble concentrating											
Total cognitive score (out of 40)												
If more than 24 hours post-injury, please also rate these physical symptoms												
	I get angry or irritated easily											
	I feel restless											
	I feel tired during the day											
	I need to sleep a lot more or find it hard to sleep at night											

10. If severe headache, consider referral to Emergency Department.

Total symptom severity score within 24 hours (out of 120[11])		**Total symptom severity score >24 hours (out of 160[12])**	
Number of symptoms endorsed within 24 hours (out of 12)		**Number of symptoms endorsed >24 hours (out of 16)**	
What is the dominant symptom cluster? (High proportion or most severe symptoms reported (e.g. physical, vestibular or cognitive?)			

11. If 50 or more consider referral to specialist concussion clinic, as this person is likely to be at moderate risk of poor recovery. If <50 this person is at low risk, monitor and follow up in 7-10 days.

12. If 66 or more consider referral to specialist concussion clinic, as this person is likely to be at moderate risk of poor recovery. If <66 this person is at low risk, monitor and follow up in 7-10 days. If minimal improvement in scores since previous visit, consider referral to concussion clinic.

Injuries to the brain can affect how a person feels, behaves, thinks and how able they are to do everyday tasks.

On a scale of 0 to 100, where 0 means that you do not feel the injury has had any impact on you at all and 100 means you feel that injury stops you from doing anything, how much do you feel your injury is impacting on you at this point in time?

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AUT TRAUMATIC BRAIN INJURY NETWORK

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The Child Sport Concussion Assessment Tool 5th Edition (Child SCAT5)

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ABSTRACT

This article presents the Child Sport Concussion Assessment Tool 5th Edition (Child SCAT5). The Sport Concussion Assessment Tool was introduced in 2004, following the 2nd International Conference on Concussion in Sport in Prague, Czech Republic. Following the 4th International Consensus Conference, held in Zurich, Switzerland, in 2012, the SCAT 3rd edition (Child SCAT3) was developed for children aged between 5 and12 years. Research to date was reviewed and synthesised for the 5th International Consensus Conference on Concussion in Sport in Berlin, Germany, leading to the current revision of the test, the Child SCAT5. This article describes the development of the Child SCAT5.

INTRODUCTION

The Sport Concussion Assessment Tool (SCAT) was introduced in 2004, following the 2nd International Conference on Concussion in Sport in Prague, Czech Republic.[1] The aim was to 'create a standardised tool that could be used for patient education as well as for physician assessment of sports concussion', by combining eight existing tools into one. However, the SCAT was not age-specific and was not appropriate for younger concussed children. The 3rd International Conference on Concussion in Sport, held in Zurich, Switzerland, in 2008, introduced the SCAT2 and recommended its use for athletes aged ≥10 years.[2] The 4th International Consensus Conference, held in Zurich, Switzerland, in 2012, examined the evidence for the assessment of the child athlete and determined that a child-specific tool was required. Thus, the Child SCAT3 was developed for children aged between 5 and 12 years.[3] Based on the available evidence, the Child SCAT3 incorporated several components that differed from the SCAT3. First, the Maddocks questions were modified to include questions more appropriate to children engaged in both organised and playground sport. Second, the Symptom Evaluation was changed from the adult version of the Post-Concussion Symptom Scale to the Health and Behavior Inventory, which is a validated symptom list for both child-reported and parent-reported symptoms.[4] Third, the Orientation assessment did not include the time question because most young children cannot answer this question. Fourth, the Digits Backwards introduced a two-digit string because many younger children could not perform this task with three-digit strings. Fourth, the Months in Reverse Order was changed to Days of the Week because many young children could not recite the months in order. Fifth, the Balance Examination removed the single-leg stance because many younger children were unable to perform this task. Finally, Return to School information was provided for the child athlete. To date, very few studies have been published using the Child SCAT3.[5–8]

METHODS

The 5th International Consensus Conference on Concussion in Sport, held in Berlin, Germany, in 2016, followed a consensus development process, which incorporated systematic reviews to address specific questions, and the results of the reviews were presented at the meeting in an open forum. Full methods of the 5th International Consensus Conference on Concussion in Sport are published elsewhere.[9] Poster abstracts, as well as audience questions and feedback, were included in the expert panel's deliberations following the meeting in Berlin.

A systematic review of the SCAT3 and Child SCAT3 was performed[10] and the evidence was synthesised to inform the expert panel convened to improve these tools. The panel unanimously agreed that a child-specific version of the SCAT is required. A subgroup of the Berlin Expert Panel met on a separate day to develop a revised version of the tool, the Child SCAT5. *The version number (5) was chosen to align the version number with the consensus meeting number and, therefore, there is no Child SCAT4.*

RESULTS

Based on the systematic reviews, conference discussions and panel deliberations, we made several modifications to the Child SCAT3 to create the Child SCAT5. These modifications are set out in box 1. The format of the Child SCAT5 is consistent with the SCAT5. The panel sought to minimise the changes to test elements that have demonstrated validity and are complemented by published normative data. We modified components that did not meet these criteria, as needed.

The Child SCAT5 is a tool for evaluating injured children (aged 5–12 years) suspected of having suffered concussion and is designed

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Box 1 Modifications of the Child SCAT3 for the Child SCAT5.

- The Potential Signs of Concussion Box was replaced with a 'Red Flags' Box in the initial assessment to highlight the potential of a structural brain injury that may require neurosurgical intervention.
- Declaration that the complete Child SCAT5 cannot be appropriately completed in less than 10–15 min.
- The modified Maddocks questions were removed because of the questionable reliability and usefulness in young children.
- The Symptom Evaluation is recommended to be performed with the child in a resting state.
- Neck pain was added to the list of child-reported and parent-reported symptoms.
- An overall rating of functioning (0-10) has been included for the Child Report and a rating (0-100) has been included for the Parent Report.
- The Orientation questions were removed because of their doubtful usefulness in young children.
- The Immediate Memory word lists include two additional five-word lists and optional 10-word lists are provided for older children in whom a ceiling effect is identified with the five-word lists. All six versions of the Standardised Assessment of Concussion word lists are now presented and they should be administered by choosing one at random for baseline testing and then using them serially post-injury.
- The time at completion of the third trial of the word list is recorded and the Delayed Recall is not to proceed <5 min from completion of the Immediate Recall.
- Digits Backwards has been modified to include two additional digit lists and has been formatted to assist with administration of this test, in which a correct response from one string length advances to the next string length, but an incorrect response requires a second trial at the same string length. Administration of different digit lists should be randomised at baseline and serially post injury.
- The Balance Examination includes the single-leg stance for children aged 10–12 years.
- The Neck Examination and Coordination Examination have been removed and incorporated into a new section, the Rapid Neurological Screen (RNS).
- The RNS includes assessment of balance and gait, ocular function, coordination and reading (assesses cognitive function, cranial nerves [acuity, diplopia], dysphasia, dysarthria and response time). Younger children who cannot read are asked to describe what they see in a photograph.
- The Return to School information has been modified to inform the student that prolonged school absence is not recommended and that appropriate accommodations should be made, in consultation with the medical team, teachers and parents/caregivers. The Return to School section includes a stepwise table that allows for symptom-limited cognitive activity.[13]
- The Return to Sport information has been modified to inform the student that a symptom-limited activity programme should be followed with healthcare professional guidance.[13]

for use by medical professionals. The SCAT5, for athletes aged ≥13 years, is published separately.[11] A separate tool, the Concussion Recognition Tool 5, has been developed for non-medically trained individuals for the identification and immediate management of suspected concussion and is also published separately.[12]

DISCUSSION

The Child SCAT5 is consistent with the previous version—it provides a standardised approach to the evaluation of suspected concussion that includes measures and methods valid for detecting sport-related concussion. The Child SCAT5 incorporates changes that address some of the limitations identified in the systematic review[10] and provides additional evaluative tools (eg, RNS).

The diagnosis of concussion relies on a clinical synthesis of complex, non-specific and, at times, contradictory information. Accordingly, only healthcare professionals trained in the assessment and management of sport-related concussion should use the Child SCAT5. The Child SCAT5 is a tool to assist the qualified health professional with the clinical diagnosis of concussion and is not designed to be used in isolation to make or exclude the diagnosis of concussion.

The Child SCAT5 includes comprehensive instructions for the appropriate administration of the subscales that should be carefully studied and practised prior to clinical use. Future research on the reliability and validity of the Child SCAT5 will inform further improvement of this tool. We note that there are insufficient data on the use of the Child SCAT in athletes with disabilities and across different cultures and language groups. We recommended that a systematic approach be undertaken to translate and culturally adapt the Child SCAT5 into other languages. The Concussion in Sport Group encourages research; there is a need for a comprehensive set of norms in both sexes and across ages, language groups, sports and in people with disabilities.

The Child SCAT5 is available for free, unrestricted distribution for use in childhood sport-related concussion, provided that no modifications are made to the tool. The development of the tool is evidence-informed and we encourage its widespread distribution and use by medical professionals worldwide.

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Competing interests GAD is an honorary member of the Australian Football League Concussion Working Group and has attended meetings organised by sporting organisations including the NFL (USA), National Rugby League (Australia) and FIFA (Switzerland); however, he has not received any payment, research funding or other monies from these groups other than for travel costs. LP is an expert consultant to mdBriefcase in the development of an online concussion education module and has received speaking honoraria/travel expenses for presentations at scientific meetings. KJS has received speaking honoraria for presentations at scientific meetings. She is a physiotherapy consultant at Evidence Sport and Spinal Therapy in Calgary, Alberta, Canada, and for athletic teams. KOY has received grant funding from NIH and Canadian Institutes of Health Research and book royalties from Guilford Press and Cambridge University Press and has occasionally served as an expert witness in forensic cases; he is President-Elect of the International Neuropsychological Society and a member of the Expert Panel on Acute Diagnosis and Management of Mild Traumatic Brain Injury among Children and Adolescents convened by the Centers for Disease Control and Prevention. RGE is a volunteer co-chairman of the NFL Head Neck and Spine Medical Committee. RJE is a consultant to the NHL, Major League Soccer, US Soccer Federation and Princeton University. He has received financial remuneration for these consulting relationships. He has a clinical practice in sport neuropsychology and serves as an expert (neuropsychology, sport neuropsychology) in medico-legal cases involving traumatic brain injury. He at times has received honoraria and reimbursement of expenses to attend professional meetings. MM is Consultant Sport and Exercise Medicine Physician at Olympic Park Sports Medicine Centre, Team Doctor—Hawthorn football club (Australian Football League(AFL)). AFL research grant—funding for research program on concussion in AFL (collaboration between the AFL and the Florey Institute of Neuroscience & Mental Health). Shareholder—Olympic Park Sports Medicine Centre. IOC—travel and accommodation paid as part of Ad Hoc Committee to evaluate rule changes in boxing. FIFA—Travel and accommodation paid as part of International Concussion in Sport Group. AFL—support for travel to NFL concussion 'think tank' August 2014. CogState Pty Ltd—free access to computerised neuropsychological testing program for research purposes. AFL Doctors Association—paid role as executive officer. Honorary member of the Australian Rugby Union Concussion Advisory Group; World Rugby Concussion working group; Concussion in AFL working group; AFL Concussion Scientific Committee and Member and the International Olympic Committee ad hoc group to evaluate rule change in boxing. AS is an unaffiliated neurotrauma consultant, the NFL . GLI acknowledges philanthropic research support from the Mooney-Reed Charitable Foundation and ImPACT Applications, Inc. He has a medical-legal consulting practice, including expert testimony, in the area of neuropsychology and mild traumatic brain injury. PMcC is a co-investigator, collaborator, or consultant on grants relating to mild TBI funded by several governmental organizations. He is directly employed by the National Health & Medical Research Council of Australia and is based at the Florey Institute of Neuroscience and Mental Health. 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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 2001 from CogState Inc. The Australian Football League funds research at the Florey Institute under a legal memorandum and Dr. McCrory does not receive any money from this industry funded research. Dr. McCrory 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. WM is Medical Director for the National Hockey League. JP is concussion consultant to South African Rugby's BokSmart injury prevention programme and a member of World Rugby's Concussion Advisory Group; both organisations have contributed honoraria towards conference expenses. GAG receives royalties as a test author from Psychological Assessment Resources, receives research funding from the CDC and NIH, receives speaking Honoria for professional lectures, and is on the pediatric mild TBI guidelines panel of the CDC. CCG receives grants/research support from NIH, NCAA, DoD, Today's and Tomorrow's Children Fund, UCLA Brain Injury Research Center, UCLA Faculty Grants Program, UCLA Steve Tisch BrainSPORT program, Avanir (research grant 2016-2017), NINDS Neural Analytics SBIR grant (2016-2018)Consultant: NFL-Neurological Care Program, NHLPA, Neural Analytics Inc (2015-16), is on the advisory panel of LoveYourBrain, MLS, NBA, NCAA, USSF, performs medicolegal work 1-2 cases annually, and speaks on the Medical Education Speakers Network.JSK provides consulting to National Basketball Association, National Football League Players' Association, National Hockey League Players' Association, ElMindA, Ltd. VA and JD have nothing to declare.

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