Concussion Quick Check

AMERICAN ACADEMY OF NEUROLOGY®

Use this guide to help you evaluate if someone may have a concussion and needs to see a licensed health care provider.*

EVALUATE

Know these signs and symptoms of concussion. Every athlete is unique and may experience different combinations of reactions.

Common Signs of Concussion—Things You Can Observe

- Behavior or personality changes
- Blank stare, dazed look
- Changes to balance, coordination, or reaction time
- Delayed or slowed spoken or physical responses
- Disorientation (confused about time, date, location, game)
- Loss of consciousness (blackout) (occurs in less than 10 percent of people with concussion)
- Memory loss of event before, during, or after injury occurred
- Slurred/unclear speech
- Trouble controlling emotions
- Vomiting

Symptoms of Concussion—Things the Athlete Tells You

- Blurry vision/double vision
- Confusion
- Dizziness
- Feeling hazy, foggy, or groggy
- Feeling very drowsy, having sleep problems
- Headache
- Inability to focus, concentrate
- Nausea (stomach upset)
- Not feeling right
- Sensitivity to light or sound

TAKE ACTION

What should I do if an athlete has a head injury during a game?

Immediately address safety concerns. If the person is unconscious (knocked out), check his or her Airway, Breathing, and Circulation (ABCs).

Airway: Check that the mouth and throat are not blocked

Breathing: Be sure the person is breathing normally

Circulation: Check that the person's heart is beating regularly

If you suspect the person may have a neck injury or if the person is unconscious:

- Do not move the head, neck, or spine. This could worsen any spinal injury to the neck
- Contact emergency medical services with any concern about breathing, circulation, or spinal injury
- Do not let the athlete return to play until examined and cleared by a licensed health care provider trained in diagnosing and managing concussion

SEEK CARE

What should I do if it appears the athlete has a concussion?

If a concussion is suspected, remove the athlete from play. If a concussion is diagnosed, the athlete should not return to play for the rest of the day.

- Monitor the athlete for the next three to four hours. You may need to monitor for a longer time
- Notify a licensed health care provider trained in diagnosing and managing concussion
- Do not let the athlete return to play until evaluated and cleared by a licensed health care provider trained in diagnosing and managing concussion

When is it okay for the athlete to return to play?

Clearance from a licensed health care provider trained in diagnosing and managing concussion is needed before allowing the athlete to return to play. The health care provider may:

- Advise the athlete to return to physical activity slowly
- Explain the process for this clearly
- Tell the athlete to increase activity levels carefully, step by step

Remember, if the person has any concussion symptoms, he or she should not advance to the next activity level. Before full return to play, the final activity level should imitate game conditions as much as possible.

LEARN MORE

Some US states have passed laws on managing concussion. Be sure to learn about and follow any concussion law in your state.

Learn more about the AAN's guideline on concussion at *www.aan.com/concussion.*

DOWNLOAD APP

Download the AAN's Concussion Quick Check app to your smartphone or tablet to find a neurologist near you and consult concussion laws in your state.

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Consensus statement on concussion in sport—the 5th international conference on concussion in sport held in Berlin, October 2016

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PREAMBLE

The 2017 Concussion in Sport Group (CISG) consensus statement is designed to build on the principles outlined in the previous statements[1–4] and to develop further conceptual understanding of sport-related concussion (SRC) using an expert consensus-based approach. This document is developed for physicians and healthcare providers who are involved in athlete care, whether at a recreational, elite or professional level. While agreement exists on the principal messages conveyed by this document, the authors acknowledge that the science of SRC is evolving and therefore individual management and return-to-play decisions remain in the realm of clinical judgement.

This consensus document reflects the current state of knowledge and will need to be modified as new knowledge develops. It provides an overview of issues that may be of importance to healthcare providers involved in the management of SRC. This paper should be read in conjunction with the systematic reviews and methodology paper that accompany it. First and foremost, this document is intended to guide clinical practice; however, the authors feel that it can also help form the agenda for future research relevant to SRC by identifying knowledge gaps.

A series of specific clinical questions were developed as part of the consensus process for the Berlin 2016 meeting. Each consensus question was the subject of a specific formal systematic review, which is published concurrently with this summary statement. Readers are directed to these background papers in conjunction with this summary statement as they provide the context for the issues and include the scope of published research, search strategy and citations reviewed for each question. This 2017 consensus statement also summarises each topic and recommendations in the context of all five CISG meetings (that is, 2001, 2004, 2008, 2012 as well as 2016). Approximately 60 000 published articles were screened by the expert panels for the Berlin meeting. The details of the search strategies and findings are included in each of the systematic reviews.

The details of the conference organisation, methodology of the consensus process, question development and selection on expert panellists and observers is covered in detail in an accompanying paper in this issue.[5] A full list of scientific committee members, expert panellists, authors, observers and those who were invited but could not attend are detailed is at the end of the summary document. The International Committee of Medical Journal Editors conflict of interest declaration for all authors is provided in Appendix 1.

Medical legal considerations

The consensus statement is not intended as a clinical practice guideline or legal standard of care, and should not be interpreted as such. This document is only a guide, and is of a general nature, consistent with the reasonable practice of a healthcare professional. Individual treatment will depend on the facts and circumstances specific to each individual case. It is intended that this document will be formally reviewed and updated before 31 December 2020.

SRC AND ITS MANAGEMENT

The paper is laid out following the CISG's 11 'R's of SRC management to provide a logical flow of

clinical concussion management. *The new material recommendations determined at the Berlin 2016 meeting are italicised*, and any background material or unchanged recommendations from previous meetings are in normal text.

The sections are: Recognise; Remove; Re-evaluate; Rest; Rehabilitation; Refer; Recover; Return to sport; Reconsider; Residual effects and sequelae; Risk reduction.

Recognise

What is the definition of SRC?

In the broadest clinical sense, SRC is often defined as representing the immediate and transient symptoms of traumatic brain injury (TBI). Such operational definitions, however, do not give any insights into the underlying processes through which the brain is impaired, nor do they distinguish different grades of severity, nor reflect newer insights into the persistence of symptoms and/or abnormalities on specific investigational modalities. This issue is clouded not only by the lack of data, but also by confusion in definition and terminology. Often the term mild traumatic brain injury (mTBI) is used interchangeably with concussion; however, this term is similarly vague and not based on validated criteria in this context.

One key unresolved issue is whether concussion is part of a TBI spectrum associated with lesser degrees of diffuse structural change than are seen in severe TBI, or whether the concussive injury is the result of reversible physiological changes. The term concussion, while useful, is imprecise, and because disparate author groups define the term differently, comparison between studies is problematic. In spite of these problems, the CISG has provided a consistent definition of SRC since 2000.[1]

The Berlin expert panel modified the previous CISG definition as follows:

Sport related concussion is a traumatic brain injury induced by biomechanical forces. Several common features that may be utilised in clinically defining the nature of a concussive head injury include:

- *SRC may be caused either by a direct blow to the head, face, neck or elsewhere on the body with an impulsive force transmitted to the head.*
- *SRC typically results in the rapid onset of short-lived impairment of neurological function that resolves spontaneously. However, in some cases, signs and symptoms evolve over a number of minutes to hours.*
- *SRC may result in neuropathological changes, but the acute clinical signs and symptoms largely reflect a functional disturbance rather than a structural injury and, as such, no abnormality is seen on standard structural neuroimaging studies.*
- *SRC results in a range of clinical signs and symptoms that may or may not involve loss of consciousness. Resolution of the clinical and cognitive features typically follows a sequential course. However, in some cases symptoms may be prolonged.*

The clinical signs and symptoms cannot be explained by drug, alcohol, or medication use, other injuries (such as cervical injuries, peripheral vestibular dysfunction, etc) or other comorbidities (eg, psychological factors or coexisting medical conditions).

Do the published biomechanical studies inform us about the definition of SRC?

Many studies have reported head-impact-exposure patterns for specific sports—for example, American football, ice hockey and Australian football. Those studies report head-impact characteristics including frequency, head kinematics, head-impact location, and injury outcome. In these studies, the use of instrumented helmets has provided information on head-impact exposures, although there remains some debate about the accuracy and precision of the head kinematic measurements. To quantify head impacts, studies have used helmet-based systems, mouthguard/headband/skin sensors and videometric studies; however, reported mean peak linear and rotational acceleration values in concussed players vary considerably.

Although current helmet-based measurement devices may provide useful information for collision sports, these systems do not yet provide data for other (non-collision) sports, limiting the value of this approach. Furthermore, accelerations detected by a sensor or video-based systems do not necessarily reflect the impact to the brain itself, and values identified vary considerably between studies. The use of helmet-based or other sensor systems to clinically diagnose or assess SRC cannot be supported at this time.

Sideline evaluation

It is important to note that SRC is an evolving injury in the acute phase, with rapidly changing clinical signs and symptoms, which may reflect the underlying physiological injury in the brain. SRC is considered to be among the most complex injuries in sports medicine to diagnose, assess and manage. The majority of SRCs occur without loss of consciousness or frank neurological signs. At present, there is no perfect diagnostic test or marker that clinicians can rely on for an immediate diagnosis of SRC in the sporting environment. Because of this evolving process, it is not possible to rule out SRC when an injury event occurs associated with a transient neurological symptom. In all suspected cases of concussion, the individual should be removed from the playing field and assessed by a physician or licensed healthcare provider as discussed below.

Sideline evaluation of cognitive function is an essential component in the assessment of this injury. Brief neuropsychological (NP) test batteries that assess attention and memory function have been shown to be practical and effective. Such tests include the SCAT5, which incorporates the Maddocks' questions[6 7] and the Standardised Assessment of Concussion (SAC).[8–10] It is worth noting that standard orientation questions (eg, time, place, person) are unreliable in the sporting situation when compared with memory assessment.[7 11] It is recognised, however, that abbreviated testing paradigms are designed for rapid SRC screening on the sidelines and are not meant to replace a comprehensive neurological evaluation; nor should they be used as a standalone tool for the ongoing management of SRC.

A key concept in sideline assessment is the rapid screening for a suspected SRC, rather than the definitive diagnosis of head injury. Players manifesting clear on-field signs of SRC (eg, loss of consciousness, tonic posturing, balance disturbance) should immediately be removed from sporting participation. Players with a suspected SRC following a significant head impact or with symptoms can proceed to sideline screening using appropriate assessment tools—for example, SCAT5. Both groups can then proceed to a more thorough diagnostic evaluation, which should be performed in a distraction-free environment (eg, locker room, medical room) rather than on the sideline.

In cases where the physician may have been concerned about a possible concussion, but after the sideline assessment (including additional information from the athlete, the assessment itself and/or inspection of videotape of the incident) concussion is no longer suspected, then the physician can

Table 1 Graduated return-to-sport (RTS) strategy

Stage	Aim	Activity	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, eg, 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 sport	Normal game play	

NOTE: An initial period of 24–48 hours of both relative physical rest and cognitive rest is recommended before beginning the RTS progression.
There should be at least 24 hours (or longer) for each step of the progression. If any symptoms worsen during exercise, 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). If symptoms are persistent (eg, more than 10–14 days in adults or more than 1 month in children), the athlete should be referred to a healthcare professional who is an expert in the management of concussion.

determine the disposition and timing of return to play for that athlete.

We acknowledge that many contact sports are played at a fast pace in a disorganised environment, where the view of on-field incidents is often obscured and the symptoms of SRC are diverse, all of which adds to the challenge of the medical assessment of suspected SRC. Furthermore, evolving and delayed-onset symptoms of SRC are well documented and highlight the need to consider follow-up serial evaluation after a suspected SRC regardless of a negative sideline screening test or normal early evaluation.

The recognition of suspected SRC is therefore best approached using multidimensional testing guided via expert consensus. The SCAT5 currently represents the most well-established and rigorously developed instrument available for sideline assessment. There is published support for using the SCAT and Child SCAT in the evaluation of SRC. The SCAT is useful immediately after injury in differentiating concussed from non-concussed athletes, but its utility appears to decrease significantly 3–5 days after injury. The symptom checklist, however, does demonstrate clinical utility in tracking recovery. Baseline testing may be useful, but is not necessary for interpreting post-injury scores. If used, clinicians must strive to replicate baseline testing conditions. Additional domains that may add to the clinical utility of the SCAT tool include clinical reaction time, gait/balance assessment, video-observable signs and oculomotor screening.

The addition of sideline video review offers a promising approach to improving identification and evaluation of significant head-impact events, and a serial SRC evaluation process appears to be important to detect delayed-onset SRC. Other tools show promise as sideline screening tests but require adequately powered diagnostic accuracy studies that enrol a representative sample of athletes with suspected SRC. Collaboration between sporting codes to rationalise multimodal diagnostic sideline protocols may help facilitate more efficient application and monitoring. Current evidence does not support the use of impact sensor systems for real-time SRC screening.

Symptoms and signs of acute SRC

Recognising and evaluating SRC in the adult athlete on the field is a challenging responsibility for the healthcare provider. Performing this task often involves a rapid assessment in the midst of competition with a time constraint and the athlete eager to play. A standardised objective assessment of injury that excludes more serious injury is critical in determining disposition decisions for the athlete. The sideline evaluation is based on recognition of injury, assessment of symptoms, cognitive and cranial nerve function, and balance. Serial assessments are often necessary. Because SRC is often an evolving injury, and signs and symptoms may be delayed, erring on the side of caution (ie, keeping an athlete out of participation when there is any suspicion of injury) is important.

The diagnosis of acute SRC involves the assessment of a range of domains including clinical symptoms, physical signs, cognitive impairment, neurobehavioral features and sleep/wake disturbance. Furthermore, a detailed concussion history is an important part of the evaluation both in the injured athlete and when conducting a pre-participation examination.

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

a. Symptoms: somatic (eg, headache), cognitive (eg, feeling like in a fog) and/or emotional symptoms (eg, lability)
b. Physical signs (eg, loss of consciousness, amnesia, neurological deficit)
c. Balance impairment (eg, gait unsteadiness)
d. Behavioural changes (eg, irritability)
e. Cognitive impairment (eg, slowed reaction times)
f. Sleep/wake disturbance (eg, somnolence, drowsiness)

If symptoms or signs in any one or more of the clinical domains are present, an SRC should be suspected and the appropriate management strategy instituted. It is important to note, however, that these symptoms and signs also happen to be non-specific to concussion, so their presence simply prompts the inclusion of concussion in a differential diagnosis for further evaluation, but the symptom is not itself diagnostic of concussion.

Remove

When a player shows any symptoms or signs of an SRC:

a. The player should be evaluated by a physician or other licensed healthcare provider on site using standard emergency management principles, and particular attention should be given to excluding a cervical spine injury.
b. The appropriate disposition of the player must be determined by the treating healthcare provider in a timely manner. If no healthcare provider is available, the player should be safely removed from practice or play and urgent referral to a physician arranged.
c. Once the first aid issues are addressed, an assessment of the concussive injury should be made using the SCAT5 or other sideline assessment tools.
d. The player should not be left alone after the injury, and serial monitoring for deterioration is essential over the initial few hours after injury.
e. A player with diagnosed SRC should not be allowed to return to play on the day of injury.

Table 2 Graduated return-to-school strategy

Stage	Aim	Activity	Goal of each step
1	Daily activities at home that do not give the child symptoms	Typical activities of the child during the day as long as they do not increase symptoms (eg, reading, texting, screen time). Start with 5–15 min 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 schoolwork. 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

When a concussion is suspected, the athlete should be removed from the sporting environment and a multimodal assessment should be conducted in a standardised fashion (eg, the SCAT5). Sporting bodies should allow adequate time to conduct this evaluation. For example, completing the SCAT alone typically takes 10 min. Adequate facilities should be provided for the appropriate medical assessment both on and off the field for all injured athletes. In some sports, this may require rule changes to allow an appropriate off-field medical assessment to occur without affecting the flow of the game or unduly penalising the injured player's team. The final determination regarding SRC diagnosis and/or fitness to play is a medical decision based on clinical judgement.

Re-evaluate

An athlete with SRC may be evaluated in the emergency room or doctor's office as a point of first contact after injury or may have been referred from another care provider. In addition to the points outlined above, the key features of follow-up examination should encompass:

a. A medical assessment including a comprehensive history and detailed neurological examination including a thorough assessment of mental status, cognitive functioning, sleep/wake disturbance, ocular function, vestibular function, gait and balance.
b. Determination of the clinical status of the patient, including whether there has been improvement or deterioration since the time of injury. This may involve seeking additional information from parents, coaches, teammates and eyewitnesses to the injury.
c. Determination of the need for emergent neuroimaging to exclude a more severe brain injury (eg, structural abnormality).

Neuropsychological assessment

Neuropsychological assessment (NP) has been previously described by the CISG as a 'cornerstone' of SRC management. Neuropsychologists are uniquely qualified to interpret NP tests and can play an important role within the context of a multifaceted—multimodal and multidisciplinary approach to managing SRC. SRC management programmes that use NP assessment to assist in clinical decision-making have been instituted in professional sports, colleges and high schools.

The application of NP testing in SRC has clinical value and contributes significant information in SRC evaluation.[12–17] Although in most cases, cognitive recovery largely overlaps with the time course of symptom recovery, cognitive recovery may occasionally precede or lag behind clinical symptom resolution, suggesting that the assessment of cognitive function should be an important component in the overall assessment of SRC and, in particular, any return-to-play protocol.[18 19] It must be emphasised, however, that NP assessment should not be the sole basis of management decisions. Rather, it provides an aid to the clinical decision-making process in conjunction with a range of assessments of different clinical domains and investigational results.

It is recommended that all athletes should have a clinical neurological assessment (including evaluation of mental status/cognition, oculomotor function, gross sensorimotor, coordination, gait, vestibular function and balance) as part of their overall management. This will normally be performed by the treating physician, often in conjunction with computerised NP screening tools.

Brief computerised cognitive evaluation tools are a commonly utilised component of these assessments worldwide given the logistical limitation in accessing trained neuropsychologists. However, it should be noted that these are not substitutes for complete NP assessment.

Baseline or pre-season NP testing was considered by the panel and was not felt to be required as a mandatory aspect of every assessment; however, it may be helpful or add useful information to the overall interpretation of these tests. It also provides an additional educative opportunity for the healthcare provider to discuss the significance of this injury with the athlete.

Post-injury NP testing is not required for all athletes. However, when this is considered necessary, the assessment should optimally be performed by a trained and accredited neuropsychologist. Although neuropsychologists are in the best position to interpret NP tests by virtue of their background and training, the ultimate return-to-play decision should remain a medical one in which a multidisciplinary approach, when possible, has been taken. In the absence of NP and other testing, a more conservative return-to-play approach may be appropriate.

Post-injury NP testing may be used to assist return-to-play decisions and is typically performed when an athlete is clinically asymptomatic. However, NP assessment may add important information in the early stages after injury.[20 21] There may be particular situations where testing is performed early to assist in determining aspects of management—for example, return to school in a paediatric athlete. This will normally be best determined in consultation with a trained neuropsychologist.[22 23]

Concussion investigations

Over the past decade, we have observed major progress in clinical methods for evaluation of SRC and in determining the natural history of clinical recovery after injury. Critical questions remain, however, about the acute neurobiological effects of SRC on brain structure and function, and the eventual time course of physiological recovery after injury. Studies using advanced neuroimaging techniques have demonstrated that SRC is associated with changes in brain structure and function, which

correlate with post-concussive symptoms and performance in neurocognitive testing during the acute post-injury phase.

The assessment of novel and selective fluid (eg, blood, saliva and cerebrospinal fluid) biomarkers and genetic testing for TBI has rapidly expanded in parallel with imaging advances, but this currently has limited application to the clinical management of SRC. Extending from the broader TBI literature, there is also increasing interest in the role of genetics in predicting risk of (i) initial injury, (ii) prolonged recovery and long-term neurological health problems associated with SRC, and (iii) repetitive head-impact exposure in athletes.

Clinically, there is a need for diagnostic biomarkers as a more objective means to assess the presence/severity of SRC in athletes. Beyond the potential diagnostic utility, there is also keen interest in the development of prognostic biomarkers of recovery after SRC. Imaging and fluid biomarkers that reliably reflect the extent of neuronal, axonal and glial damage and/or microscopic pathology could conceivably diagnose and predict clinical recovery outcome and/or determine risk of potential cumulative impairments after SRC.

Advanced neuroimaging, fluid biomarkers and genetic testing are important research tools, but require further validation to determine their ultimate clinical utility in evaluation of SRC.

Rest

Most consensus and agreement statements for managing SRC recommend that athletes rest until they become symptom-free. Accordingly, prescribed rest is one of the most widely used interventions in this population. The basis for recommending physical and cognitive rest is that rest may ease discomfort during the acute recovery period by mitigating post-concussion symptoms and/or that rest may promote recovery by minimising brain energy demands following concussion.

There is currently insufficient evidence that prescribing complete rest achieves these objectives. After a brief period of rest during the acute phase (24–48 hours) after injury, patients can be encouraged to become gradually and progressively more active while staying below their cognitive and physical symptom-exacerbation thresholds (ie, activity level should not bring on or worsen their symptoms). It is reasonable for athletes to avoid vigorous exertion while they are recovering. The exact amount and duration of rest is not yet well defined in the literature and requires further study.

Rehabilitation

This summary statement regarding the potential for concussion rehabilitation must be read in conjunction with the systematic review paper, which details the background, search strategy, citations and reasoning for this statement. As 'Rehabilitation' did not exist as a separate section in the previous Consensus Statements, this section is all in italics.

SRCs can result in diverse symptoms and problems, and can be associated with concurrent injury to the cervical spine and peripheral vestibular system. The literature has not evaluated early interventions, as most individuals recover in 10–14 days. A variety of treatments may be required for ongoing or persistent symptoms and impairments following injury. The data support interventions including psychological, cervical and vestibular rehabilitation.

In addition, closely monitored active rehabilitation programmes involving controlled sub-symptom-threshold, submaximal exercise have been shown to be safe and may be of benefit in facilitating recovery. A collaborative approach to treatment, including controlled cognitive stress, pharmacological treatment, and school accommodations, may be beneficial.

Further research evaluating rest and active treatments should be performed using high-quality designs that account for potential confounding factors, and have matched controls and effect modifiers to best inform clinical practice and facilitate recovery after SRC.

Refer

Persistent symptoms

A standard definition for persistent post-concussive symptoms is needed to ensure consistency in clinical management and research outcomes. The Berlin expert consensus is that use of the term 'persistent symptoms' following SRC should reflect failure of normal clinical recovery—that is, symptoms that persist beyond expected time frames (ie, >10–14 days in adults and >4 weeks in children).

'Persistent symptoms' does not reflect a single pathophysiological entity, but describes a constellation of non-specific post-traumatic symptoms that may be linked to coexisting and/or confounding factors, which do not necessarily reflect ongoing physiological injury to the brain. A detailed multimodal clinical assessment is required to identify specific primary and secondary pathologies that may be contributing to persisting post-traumatic symptoms. At a minimum, the assessment should include a comprehensive history, focused physical examination, and special tests where indicated (eg, graded aerobic exercise test). Currently, while there is insufficient evidence for investigations, such as EEG, advanced neuroimaging techniques, genetic testing and biomarkers, to recommend a role in the clinical setting, their use in the research setting is encouraged.

Treatment should be individualised and target-specific medical, physical and psychosocial factors identified on assessment. There is preliminary evidence supporting the use of:

a. *an individualised symptom-limited aerobic exercise programme in patients with persistent post-concussive symptoms associated with autonomic instability or physical deconditioning, and*
b. *a targeted physical therapy programme in patients with cervical spine or vestibular dysfunction, and*
c. *a collaborative approach including cognitive behavioural therapy to deal with any persistent mood or behavioural issues.*

Currently, there is limited evidence to support the use of pharmacotherapy. If pharmacotherapy is used, then an important consideration in return to sport is that concussed athletes should not only be free from concussion-related symptoms, but also should not be taking any pharmacological agents/medications that may mask or modify the symptoms of SRC. Where pharmacological therapy may be begun during the management of an SRC, the decision to return to play while still on such medication must be considered carefully by the treating clinician.

Overall, these are difficult cases that should be managed in a multidisciplinary collaborative setting, by healthcare providers with experience in SRC.

Recovery

There is tremendous interest in identifying factors that might influence or modify outcome from SRC. Clinical recovery is defined functionally as a return to normal activities, including school, work and sport, after injury. Operationally, it encompasses

a resolution of post-concussion-related symptoms and a return to clinically normal balance and cognitive functioning.

It is well established that SRCs can have large adverse effects on cognitive functioning and balance in the first 24–72 hours after injury. Injured athletes report diverse physical, cognitive and emotional symptoms during the initial days after injury, and a greater number and severity of symptoms after an SRC predict a slower recovery in some studies.

For most injured athletes, cognitive deficits, balance and symptoms improve rapidly during the first 2 weeks after injury. Many past studies, particularly those published before 2005, concluded that most athletes recover from SRC and return to sport within 10 days. This is generally true, but that conclusion should be tempered by the fact that many studies reported group-level findings only, not clinical outcomes from individual athletes, and group statistical analyses can obscure subgroup results and individual differences. There is also historical evidence that some athletes returned to play while still symptomatic, well before they were clinically recovered. Moreover, during the past 10 years, there has been a steadily accumulating literature that a sizeable minority of youth, high-school and collegiate athletes take much longer than 10 days to clinically recover and return to sport.

Some authors have suggested that the longer recovery times reported in more recent studies partially reflects changes in the medical management of SRC, with adoption of the gradual return-to-play recommendations from the CISG statements. This seems likely because these return-to-play recommendations include no same-day return to play and a sequential progression through a series of steps before medical clearance for return to sport. Longer recovery times reported by some studies are also significantly influenced by ascertainment bias—that is, studies that rely, or report data, on clinical samples have a major selection bias and will report longer recovery times than those reported from truly incident cohort studies that provide a more accurate estimate of recovery time.

At present, it is reasonable to conclude that the large majority of injured athletes recover, *from a clinical perspective*, within the first month of injury. Neurobiological recovery might extend beyond clinical recovery in some athletes. Clinicians know that some student athletes report persistent symptoms for many months after injury, that there can be multiple causes for those symptoms, and that those individuals are more likely to be included in studies conducted at specialty clinics. There is a growing body of literature indicating that psychological factors play a significant role in symptom recovery and contribute to risk of persistent symptoms in some cases.

Researchers have investigated whether pre-injury individual differences, initial injury severity indicators, acute clinical effects, or subacute clinical effects or comorbidities influence outcome after SRC. Numerous studies have examined whether genetics, sex differences, younger age, neurodevelopmental factors such as attention deficit hyperactivity disorder or learning disability, personal or family history of migraine, or a personal or family history of mental health problems are predictors or effect modifiers of clinical recovery from SRC. Having a past SRC is a risk factor for having a future SRC, and having multiple past SRCs is associated with having more physical, cognitive and emotional symptoms before participation in a sporting season. Therefore, it is not surprising that researchers have studied whether having prior SRCs is associated with slower recovery from an athlete's next SRC. There have been inconsistent findings regarding whether specific *injury severity characteristics*, such as loss of consciousness, retrograde amnesia, or post-traumatic amnesia, are associated with greater acute effects or prolonged recovery. Numerous *post-injury clinical factors*, such as the initial severity of cognitive deficits, the development of post-traumatic headaches or migraines, experiencing dizziness, difficulties with oculomotor functioning, and experiencing symptoms of depression have all been associated with worse outcomes in some studies.

The strongest and most consistent predictor of slower recovery from SRC is the severity of a person's initial symptoms in the first day, or initial few days, after injury. Conversely, and importantly, having a low level of symptoms in the first day after injury is a favourable prognostic indicator. The development of subacute problems with migraine headaches or depression are likely risk factors for persistent symptoms lasting more than a month. Children, adolescents and young adults with a pre-injury history of mental health problems or migraine headaches appear to be at somewhat greater risk of having symptoms for more than 1 month. Those with attention deficit hyperactivity disorder or learning disabilities might require more careful planning and intervention regarding returning to school, but they do not appear to be at substantially greater risk of persistent symptoms beyond a month. Very little research to date has been carried out on children under the age of 13. There is some evidence that the teenage years, particularly the high-school years, might be the most vulnerable time period for having persistent symptoms—with greater risk for girls than boys.

Establishing time of recovery for SRC

Establishing the time of recovery after an SRC is a difficult task for healthcare providers. These determinations have been limited by lack of a gold standard as well as subjective symptom scores and imperfect clinical and NP testing. In addition, patients frequently experience more persistent symptoms, including, but not limited to, chronic migraines, anxiety, post-traumatic stress disorder (PTSD), attention problems and sleep dysfunction. Clinicians must determine whether these are premorbid maladies, downstream effects of SRC, or unrelated challenges while being mindful of the potential for repeat injuries when returning patients to sport too early. Providers are often left in a quandary with limited data to make decisions. Moreover, recent literature suggests that the physiological time of recovery may outlast the time for clinical recovery. The consequence of this is as yet unknown, but one possibility is that athletes may be exposed to additional risk by returning to play while there is ongoing brain dysfunction.

In a research context, modalities that measure physiological change after SRC can be categorised into the following:

- *functional MRI (fMRI)*
- *diffusion tensor imaging (DTI)*
- *magnetic resonance spectroscopy (MRS)*
- *cerebral blood flow (CBF)*
- *electrophysiology*
- *heart rate*
- *measure of exercise performance*
- *fluid biomarkers*
- *transcranial magnetic stimulation (TMS).*

Owing to differences in modalities, time course, study design and outcomes, it is not possible to define a single 'physiological time window' for SRC recovery. Multiple studies suggest that physiological dysfunction may outlast current clinical measures of recovery, supporting a 'buffer zone' of gradually increasing activity before full contact risk. Future studies need to use generalisable populations, longitudinal designs following

to physiological and clinical recovery, and careful correlation of neurobiological modalities with clinical measures. At this stage, these modalities, while useful as research tools, are not ready for clinical management.

Return to sport

Graduated return to sport

The process of recovery and then return to sport participation after an SRC follows a graduated stepwise rehabilitation strategy, an example of which is outlined in table 1. This table has been modified from previous versions to improve clarity.

After a brief period of initial rest (24–48 hours), symptom-limited activity can be begun while staying below a cognitive and physical exacerbation threshold (stage 1). Once concussion-related symptoms have resolved, the athlete should continue to proceed to the next level if he/she meets all the criteria (eg, activity, heart rate, duration of exercise, etc) without a recurrence of concussion-related symptoms. Generally, each step should take 24 hours, so that athletes would take a minimum of 1 week to proceed through the full rehabilitation protocol once they are asymptomatic at rest. However, the time frame for RTS may vary with player age, history, level of sport, etc, and management must be individualised.

In athletes who experience prolonged symptoms and resultant inactivity, each step may take longer than 24 hours simply because of limitations in physical conditioning and recovery strategies outlined above. This specific issue of the role of symptom-limited exercise prescription in the setting of prolonged recovery is discussed in an accompanying systematic review.[24] If any concussion-related symptoms occur during the stepwise approach, the athlete should drop back to the previous asymptomatic level and attempt to progress again after being free of concussion-related symptoms for a further 24 hour period at the lower level.

Reconsider

The CISG also considered whether special populations should be managed differently and made recommendations for elite and young athletes.

Elite and non-elite athletes

All athletes, regardless of level of participation, should be managed using the same management principles noted above.

The child and adolescent athlete

The management of SRC in children requires special paradigms suitable for the developing child. The paucity of studies that are specific to children, especially younger children, needs to be addressed as a priority, with the expectation that future CISG consensus meetings will have sufficient studies to review that are age-specific, of high quality, and with a low risk of bias.

We recommend that child and adolescent guidelines refer to individuals 18 years or less. Child-specific paradigms for SRC should apply to children aged 5–12 years, and adolescent-specific paradigms should apply to those aged 13–18 years. The literature does not adequately address the question of age groups in which children with SRC should be managed differently from adults. No studies have addressed whether SRC signs and symptoms differ from adults. The expected duration of symptoms in children with SRC is up to 4 weeks, and further research is required to identify predictors of prolonged recovery. It is recommended that age-specific validated symptom-rating scales be used in SRC assessment, and further research is required to establish the role and utility of computerised NP testing in this age group. Similar to adults, a brief period of physical and cognitive rest is advised after SRC followed by symptom-limited resumption of activity.

Schools are encouraged to have an SRC policy that includes education on SRC prevention and management for teachers, staff, students and parents, and should offer appropriate academic accommodation and support to students recovering from SRC. Students should have regular medical follow-up after an SRC to monitor recovery and help with return to school, and students may require temporary absence from school after injury.

Children and adolescents should not return to sport until they have successfully returned to school. However, early introduction of symptom-limited physical activity is appropriate.

An example of the return-to-school progression is in table 2.

Residual effects and sequelae

This summary statement regarding the potential for long-term sequelae following recurrent head trauma must be read in conjunction with the systematic review paper, which details the background, search strategy, citations and reasoning for this statement.[25]

The literature on neurobehavioral sequelae and long-term consequences of exposure to recurrent head trauma is inconsistent. Clinicians need to be mindful of the potential for long-term problems such as cognitive impairment, depression, etc in the management of all athletes. However, there is much more to learn about the potential cause-and-effect relationships of repetitive head-impact exposure and concussions. The potential for developing chronic traumatic encephalopathy (CTE) must be a consideration, as this condition appears to represent a distinct tauopathy with an unknown incidence in athletic populations. A cause-and-effect relationship has not yet been demonstrated between CTE and SRCs or exposure to contact sports. As such, the notion that repeated concussion or subconcussive impacts cause CTE remains unknown.

The new US National Institutes of Neurological Disease and Stroke (NINDS) and National Institute of Biomedical Imaging and Bioengineering (NIBIB) consensus criteria provide a standardised approach for describing the neuropathology of CTE. More research on CTE is needed to better understand the incidence and prevalence, the extent to which the NP findings cause specific clinical symptoms, the extent to which the neuropathology is progressive, the clinical diagnostic criteria, and other risk or protective factors. Ideally, well-designed case–control or cohort studies can begin to answer these important questions.

Risk reduction

Role of pre-participation SRC evaluation

Acknowledging the importance of an SRC history, and appreciating the fact that many athletes will not recognise all the SRCs they may have suffered in the past, a detailed SRC history is of value.[26–29] Such a history may identify athletes who fit into a high-risk category and provides an opportunity for the healthcare provider to educate the athlete as to the significance of concussive injury.

A structured SRC history should include specific questions as to previous symptoms of an SRC and length of recovery, not just the perceived number of past SRCs. Note that dependence on the recall of concussive injuries by teammates or coaches is unreliable.[26] The clinical history should also include information about all previous head, face or cervical spine injuries, as these may also have clinical relevance. In the setting of maxillofacial and cervical spine injuries, coexistent concussive injuries

may be missed unless specifically assessed. Questions pertaining to disproportionate impact versus symptom-severity matching may alert the clinician to a progressively increasing vulnerability to injury. As part of the clinical history, the health practitioner should seek details regarding protective equipment used at the time of injury for both recent and remote injuries.

There is an additional and often unrecognised benefit of the pre-participation physical examination insofar as the evaluation provides an educative opportunity with the player concerned, as well as consideration of modification of playing behaviour if required.

Prevention

While it is impossible to eliminate all concussion in sport, concussion-prevention strategies can reduce the number and severity of concussions in many sports. Until the past decade, there has been a relative paucity of scientifically rigorous evaluation studies examining the effectiveness of concussion-prevention strategies in sport.

The evidence examining the protective effect of helmets in reducing the risk of SRC is limited in many sports because of the nature of mandatory helmet regulations. There is sufficient evidence in terms of reduction of overall head injury in skiing/snowboarding to support strong recommendations and policy to mandate helmet use in skiing/snowboarding. The evidence for mouthguard use in preventing SRC is mixed, but meta-analysis suggests a non-significant trend towards a protective effect in collision sports, and rigorous case–control designs are required to further evaluate this finding.

The strongest and most consistent evidence evaluating policy is related to body checking in youth ice hockey (ie, disallowing body checking under age 13), which demonstrates a consistent protective effect in reducing the risk of SRC. This evidence has informed policy change in older age groups in non-elite levels, which requires further investigation.

There is minimal evidence to support individual injury-prevention strategies addressing intrinsic risk factors for SRC in sport. However, there is some promise that vision training in collegiate American football players may reduce SRC. Limiting contact in youth football practices has demonstrated some promising results in reducing the frequency of head contact, but there is no evidence to support the translation of these findings to a reduction in SRC. Evaluation of fair play rules in youth ice hockey, tackle training without helmets and shoulder pads in youth American football, and tackle technique training in professional rugby do not lead to a reduction in SRC risk. A recommendation for stricter rule enforcement of red cards for high elbows in heading duels in professional soccer is based on evidence supporting a reduced risk of head contacts and concussion with such enforcement.

Despite a myriad of studies examining SRC-prevention interventions across several sports, some findings remain inconclusive because of conflicting evidence, lack of rigorous study design, and inherent study biases. A clear understanding of potentially modifiable risk factors is required to design, implement and evaluate appropriate prevention interventions to reduce the risk of SRC. In addition, risk factors should be considered as potential confounders or effect modifiers in any evaluation. Biomechanical research (eg, video-analysis) to better understand injury risk behaviour and mechanisms of injury associated with rules will better inform practice and policy decisions. In addition, psychological and sociocultural factors in sport play a significant role in the uptake of any injury-prevention strategy and require consideration.

Knowledge translation

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

As the ability to treat or reduce the effects of concussive injury after the event is an evolving science, education of athletes, colleagues and the general public is a mainstay of progress in this field. Athletes, referees, administrators, parents, coaches and healthcare providers must be educated regarding the detection of SRC, its clinical features, assessment techniques and principles of safe return to play. Methods to improve education, including web-based resources, educational videos and international outreach programmes, are important in delivering the message. Fair play and respect for opponents are ethical values that should be encouraged in all sports and sporting associations. Similarly, coaches, parents and managers play an important part in ensuring these values are implemented on the field of play.[30–43]

In addition, the support and endorsement of sporting bodies such as the International Ice Hockey Federation, Fédération Internationale de Football Association (FIFA) and the International Olympic Committee who initiated this endeavour, as well as organisations that have subsequently supported the CISG meetings, including World Rugby, the International Equestrian Federation and the International Paralympic Committee, should be commended.

CONCLUSION

Since the 1970s, clinicians and scientists have begun to distinguish SRC from other causes of concussion and mTBI, such as motor vehicle crashes. While this seems like an arbitrary separation from other forms of TBI, which account for 80% of such injuries,[44 45] it is largely driven by sporting bodies that see the need to have clear and practical guidelines to determine recovery and safe return to play for athletes with an SRC.

In addition, sports participation provides unique opportunities to study SRC and mTBI, given the detailed SRC phenotype data that are typically available in many sports.[46] Having said that, it is critical to understand that the lessons derived from non-sporting mTBI research informs the understanding of SRC (and vice versa), and this arbitrary separation of sporting versus non-sporting TBI should not be viewed as a dichotomous or exclusive view of TBI. One of the standout features of the Berlin CISG meeting was the engagement by experts from the TBI, dementia, imaging and biomarker world in the process and as coauthors of the systematic reviews, which are published in issue 10 of the *British Journal of Sports Medicine* (Volume 51, 2017).

This consensus document reflects the current state of knowledge and will need to be modified according to the development of new knowledge. It should be read in conjunction with the systematic reviews and methodology papers that accompany this document (*British Journal of Sports Medicine*, issues 9 and 10, 2017). This document is first and foremost intended to inform clinical practice; however, it must be remembered that, while agreement exists on the principal messages conveyed by this document, the authors acknowledge that the science of concussion is incomplete and therefore management and return-to-play decisions lie largely in the realm of clinical judgement on an individualised basis.

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APPENDIX 1

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Consensus statement on concussion in sport ––the 5th international conference on concussion in sport held in Berlin, October 2016

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Notes

Brain or Strain? Symptoms Alone Do Not Distinguish Physiologic Concussion From Cervical/Vestibular Injury

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Objective: To compare symptoms in patients with physiologic postconcussion disorder (PCD) versus cervicogenic/vestibular PCD. We hypothesized that most symptoms would not be equivalent. In particular, we hypothesized that cognitive symptoms would be more often associated with physiologic PCD.

Design: Retrospective review of symptom reports from patients who completed a 22-item symptom questionnaire.

Setting: University-based concussion clinic.

Patients: Convenience sample of 128 patients who had symptoms after head injury for more than 3 weeks and who had provocative treadmill exercise testing.

Independent Variables: Subjects were classified as either physiologic PCD (abnormal treadmill performance and a normal cervical/vestibular physical examination) or cervicogenic/vestibular PCD (CGV, normal treadmill performance, and an abnormal cervical/vestibular physical examination).

Main Outcome Measures: Self-reported symptoms. Univariate and multivariate methods, including *t* tests, tests of equivalence, a logistic regression model, k-nearest neighbor analysis, multidimensional scaling, and principle components analysis were used to see whether symptoms could distinguish PCD from CGV.

Results: None of the statistical methods used to analyze self-reported symptoms was able to adequately distinguish patients with PCD from patients with CGV.

Conclusions: Symptoms after head injury, including cognitive symptoms, have traditionally been ascribed to brain injury, but they do not reliably discriminate between physiologic PCD and cervicogenic/vestibular PCD. Clinicians should consider specific testing of exercise tolerance and perform a physical examination of the cervical spine and the vestibular/ocular systems to determine the etiology of postconcussion symptoms.

Clinical Relevance: Symptoms after head injury, including cognitive symptoms, do not discriminate between concussion and cervical/vestibular injury.

Key Words: concussion, cervical, symptoms, vestibular, strain

(*Clin J Sport Med* 2014;0:1–6)

INTRODUCTION

Sport-related concussion (SRC) is defined by the 2012 Zurich Consensus Statement on Concussion in Sport as "a complex pathophysiological process affecting the brain, induced by biomechanical forces…, which may be caused either by a direct blow to the head, face, neck, or elsewhere on the body with an "impulsive" force transmitted to the head."[1] Rather than constituting a single entity, however, concussion is a heterogeneous disorder that can be modified by factors such as genetics, age, gender, premorbid illness, and symptom burden.[2,3] Because there is no gold standard diagnostic test, concussion is a clinical diagnosis based on a combination of physical signs and subjective somatic, cognitive, and neurobehavioral symptoms that typically diminish over a matter of several days to weeks.[1] Approximately 10% of concussed athletes, however, experience prolonged signs and symptoms of concussion for more than 2 weeks.[4,5]

Symptoms after head injury may not be specific to the brain. Leslie and Craton[6] recently hypothesized that concussion is really a syndrome that does not require brain involvement in all cases and that concussion symptoms can emanate from the cervical spine. Concomitant injury to the cervical spine resembling whiplash may occur as a result of the acceleration–deceleration forces sustained in concussive trauma.[7] Structural and functional injury to the cervical spine can be associated with prolonged symptoms such as headache, dizziness, blurred vision, and vertigo.[8,9] Cognitive complaints, including poor concentration and memory deficits, have also been reported after whiplash injury.[10] Symptoms such as headache, dizziness, poor memory, and vertigo may therefore result either from a brain injury, from injury to the cervical spine, or from injury to both. As a brain injury, however, it would be reasonable to hypothesize that cognitive symptoms would reliably identify concussion from other potential symptom generators.

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The pathophysiology of SRC is not fully understood. There are neurotransmitter and ion disturbances that persist for hours to days[11] as well as altered autonomic nervous system function and control of cerebral blood flow that can persist for days to weeks.[12,13] This metabolic and physiologic dysfunction produces symptoms that can be exacerbated by cognitive activity and by exercise.[1,14] Exercise exacerbation of symptoms has been used systematically at our institution to define a homogeneous cohort of head-injured patients with "physiologic concussion" that, based on the response to exercise challenge and using physical examination findings, can be differentiated from patients with a cervical and/or vestibular source of symptoms after head injury.[15] Thus, there are specific diagnostic groups within the larger array of concussed individuals, and it would be useful to clinicians if symptom patterns after head injury could be used to differentiate among these conditions since the treatment approach and prognosis differ.[15]

The purpose of this study was to compare the symptom reports of a cohort of patients diagnosed with physiologic concussion with those diagnosed with a cervical/vestibular source of symptoms. We hypothesized that the presenting symptom reports of those with physiologic concussion would not be equivalent to the symptom reports of those with cervical/vestibular injury and that cognitive symptoms would be especially useful in discriminating between the 2 groups.

METHODS

Study Design

Retrospective review of symptom reports from patients who completed a 22-symptom Post-Concussion Symptom Scale (PCS) questionnaire, a validated instrument for assessing concussion symptoms with normative data in males, females, and athletes (see **Appendix**, **Supplemental Digital Content 1**, http://links.lww.com/JSM/A49, Symptom Evaluation Form).[16] Each of the 22 symptoms are endorsed on a 0 to 6 scale with descriptors for "none" (0), "mild" (1-2), "moderate" (3-4), and "severe" (5-6). This questionnaire included 4 symptoms considered "cognitive" in a previous study (difficulty concentrating, difficulty remembering, feeling slowed down, and feeling mentally foggy).[17] Subjects were diagnosed with postconcussion disorder (PCD) if their symptoms persisted for more than 3 weeks, which is consistent with expert opinion on when athletes are experiencing delayed recovery.[18]

The University at Buffalo Institutional Review Board approved the study without the requirement for obtaining consent because it was a retrospective review of clinical chart data.

Subjects

Subjects constituted a convenience sample of university-based concussion clinic patients who had symptoms after head injury that persisted for more than 3 weeks and who chose to undergo treadmill exercise testing to determine the etiology of their symptoms. This sample of 128 subjects represents 23% (128/549) of all patients with concussion (acute and those with PCD) seen between July 2007 and April 2012. This sample of patients represents those who experienced prolonged symptoms (>3 weeks) that prevented return to play or work and who were judged safe for treadmill exercise. Patients with acute concussion having a typical recovery would not undergo treadmill testing unless they were not sure if they were really ready to return to sport. Other patients with PCS did not have treadmill testing because of comorbidities. See Table 1 for a description of the subjects. Subjects were classified as either physiologic PCD or cervicogenic/vestibular (CGV) PCD based on their response to a treadmill test, the Buffalo Concussion Treadmill Test (BCTT).[14] Physiologic concussion was defined by a submaximal symptom-limited threshold on the BCTT, whereas CGV was defined by the ability to exercise to exhaustion without a submaximal symptom-limited threshold plus having abnormalities on the cervical physical examination (eg, tenderness, spasm, or reduced motion). Cervicogenic/vestibular subjects could also have had accompanying vestibular and/or ocular physical examination abnormalities such as abnormal tandem gait, abnormal ocular convergence, or abnormal signs/symptoms with smooth visual pursuits or saccades. Twelve subjects who were diagnosed with a combination of both physiologic and cervical/vestibular disorders, based on exercise intolerance on the BCTT plus cervical and vestibular physical examination abnormalities, were included in the PCD group because they had demonstrated a submaximal symptom-limited threshold on the treadmill test. We excluded patients who had recovered from concussion (n = 23) and those who had a primary diagnosis of migraine headache. The PCS symptom scale was administered on the same day but before the treadmill test.

Statistical Methods

Univariate and multivariate methods were used to ascertain the extent to which physiological (PCD) and CGV PCDs could be distinguished. Ten subjects had missing data for one or more of the 22 symptoms. Using the remaining 118 participants with complete data, a univariate analysis of each of the 22 symptoms involving formal tests of statistical difference and equivalence was conducted on a symptom by symptom basis. Tests of difference were conducted using Welch T test and independent sample *t* tests. Tests of equivalence were conducted using the two one-sided test approach with an epsilon value set equal to the estimated standard error.[19] With 22 individual variables tested and using a *P* value of 0.05, we would expect that by chance alone, 1 to 2 variables would meet statistical significance for differences. Thus, a Bonferroni correction was used to adjust for multiple comparisons.

Joint analyses of all 22 questions were conducted using the 118 participants with complete data for all 22 symptoms. A logistic regression model was built using a stepwise Akaike Information Criterion modeling algorithm with both forward and backward admissible steps. Additionally, several "k-nearest neighbor" (knn) classifiers were implemented using the Euclidean distance metric. Patients were classified into groups based on each of these analyses, and the predictive ability of the models was examined.

TABLE 1. Demographic Information for the Physiologic PCD and Cervicogenic/Vestibular Diagnostic Groups*

	Physiologic (n = 36)	Cervicogenic/Vestibular (n = 92)
Age (y)—mean (SD)	28.0 (13.9)	26.4 (13.0)
Male gender—count (%)	20 (56)	49 (53)
Athlete—count (%)	19 (53)	39 (42)
Weight (kg)—mean (SD)	74.6 (12.5)	70.1 (16.4)
Months injury to BCTT—mean (SD)	8.4 (18.7)	10.2 (19.1)

*All group differences were nonsignificant.

Multidimensional scaling (MDS), using both Euclidean and Gower distance metrics, was used to visualize the 22-dimensioned symptom space in only 2 dimensions, to test whether subjects could be classified into the 2 hypothesized diagnostic groups. A Principal Components Analysis was also conducted, and the data were projected into the 2-dimensional space defined by the first 2 principal components.

RESULTS

The *t* tests for differences between the PCD and CGV groups for each of the 22 individual symptoms reached significance (uncorrected for multiple comparisons) for "headache" and "sleep more than usual." Fatigue approached significance. These differences were not, however, significant after correction for multiple comparisons using a Bonferroni-corrected familywise error rate of 0.05. Separate analysis of the group of 12 subjects with combined PCD/CGV using independent sample *t* tests did not reveal any significant differences from the larger PCD group.

The tests of equivalence conducted using the two one-sided test approach did not reach significance. The results of the *t* tests and the tests of equivalence are summarized in Table 2. Cognitive symptoms (difficulty concentrating, difficulty remembering, feeling slowed down, feeling mentally foggy) were considered indeterminate.

The stepwise logistic regression analysis misclassified 24 of 33 participants with a PCD diagnosis, or 73%. One of the 85 participants with a diagnosis of CGV was misclassified. The logistic model was unable to adequately distinguish patients with PCD from those with CGV. Similarly, the k-nearest neighbor analysis was also unable to adequately distinguish patients with PCD from patients with CGV. For example, with k = 4, 88% of the patients with PCD were misclassified as CGV, and 18% of the patients with CGV were misclassified as PCD.

TABLE 2. Symptom Mean, SDs, and Univariate Hypothesis and Equivalence Test Results

Symptom	PCS (n = 36)	CVG (n = 92)	Welch T Test *P*	Two One-Sided Test *P*	Decision
Headache	3.1 (1.4)	2.4 (1.7)	0.0119	0.9407	Significant difference
Nausea	1.1 (1.4)	0.9 (1.3)	0.3982	0.441	Indeterminate
Vomiting	0.1 (0.7)	0.1 (0.2)	0.5314	0.3572	Indeterminate
Balance problems	1.7 (1.6)	1.6 (1.6)	0.597	0.3205	Indeterminate
Dizziness	1.8 (1.6)	1.7 (1.6)	0.6924	0.2744	Indeterminate
Fatigue	2.9 (1.7)	2.3 (1.8)	0.0772	0.7849	Suggestive difference
Trouble falling asleep	2.7 (2.2)	2.0 (2.0)	0.1502	0.6757	Indeterminate
Sleeping more than usual	0.8 (1.4)	1.5 (1.8)	0.0422	0.8548	Significant difference
Sleeping less than usual	1.7 (2.2)	1.3 (1.9)	0.3536	0.4743	Indeterminate
Drowsiness	2.3 (1.6)	1.9 (1.7)	0.1971	0.6187	Indeterminate
Sensitivity to light	2.0 (1.7)	2.1 (1.7)	0.7326	0.2568	Indeterminate
Sensitivity to noise	2.1 (2.0)	2.9 (1.8)	0.6115	0.3132	Indeterminate
Irritability	2.1 (1.9)	1.2 (1.6)	0.6602	0.2893	Indeterminate
Sadness	1.7 (2.0)	1.2 (1.6)	0.147	0.6806	Indeterminate
Nervousness	1.7 (1.9)	1.3 (1.6)	0.2567	0.558	Indeterminate
Feeling more emotional	2.1 (2.0)	1.4 (1.8)	0.1003	0.7474	Indeterminate
Numbness and tingling	0.8 (1.4)	0.8 (1.4)	0.837	0.2152	Indeterminate
Feeling slowed down	2.8 (1.8)	2.2 (2.0)	0.1264	0.7069	Indeterminate
Feeling mentally foggy	2.8 (1.9)	2.4 (2.1)	0.3589	0.4697	Indeterminate
Difficulty concentrating	3.0 (1.8)	2.8 (1.9)	0.6617	0.2885	Indeterminate
Difficulty remembering	2.5 (2.0)	2.3 (2.0)	0.6213	0.3081	Indeterminate
Visual problems	1.2 (1.6)	1.4 (1.7)	0.5242	0.3601	Indeterminate

CVG, cervicogenic/vestibular PCD.

The plots from the MDS analysis of the subjects (not shown) confirmed the previous analyses. Differences between response distributions of the PCD and CGV groups were small compared with the overall variability of the data. Multidimensional scaling projections into 2-dimensional space did not provide differential clustering of patients with PCD and those with CGV.

The results of the principle components analysis were similar to those from the MDS analysis. Figure illustrates that subjects do not cluster into 2 distinct groups. Plots of the rotation coefficients (not shown) for symptoms for the first 2 principal components indicated that symptom 3 (nausea) and symptom 8 (sleep more than usual) might contribute to a larger portion of the observed variability in the data for the first 2 principle components than other symptoms. Sleep-related symptoms 7, 8, and 9 seem to make the largest relative contributions to the second principal component.

DISCUSSION

The results of our study suggest that symptoms reported on the PCS do not accurately distinguish between patients with physiologic concussion versus those with cervicogenic/vestibular symptoms after head injury. Our univariate analysis yielded mostly indeterminate results, in that none of the tests for statistical difference nor the tests for statistical equivalence between the 2 diagnostic groups were significant at a family-wise controlled error rate of 0.05. Although it is possible that some differences with respect to certain symptoms could emerge as discriminatory in a larger sample, our multivariate analyses strongly suggest that the classifiers built upon such symptom responses are likely to have problems with accuracy. We took several optimistic looks at the data using multivariate methods and were unable to detect evidence that the variability associated with the differences in symptom responses between diagnostic groups was large when compared with the overall variability in the data. Our classifiers failed to provide evidence of sufficient accuracy, even when we overfit the models and ascertained their effectiveness to predict the same data upon which they were built (ie, providing an overly optimistic estimator of predictive accuracy). Thus, we rejected our hypothesis that the symptom reports of those with physiologic concussion would distinguish symptoms from those with cervical/vestibular injury. Although, intuitively, cognitive symptoms would seem likely to distinguish between injury to the brain and injury to the neck, our results were indeterminate. A previous study found that neuropsychological test results did not discriminate between whiplash patients and those with moderate to severe traumatic brain injury.[20]

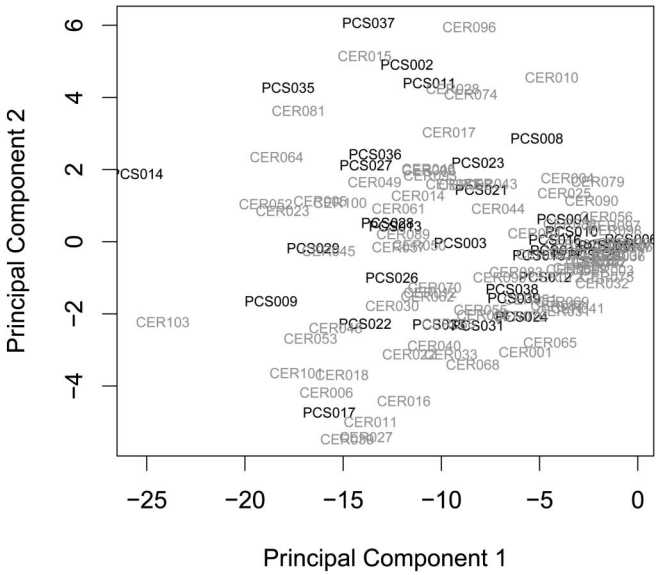

FIGURE. Subjects (n = 118) projected into the 2-dimensional space defined by the first 2 principal components. There is no separation of subjects into distinct clusters.

The symptoms of concussion reported after head injury have traditionally been ascribed to brain injury, but there is actually little evidence to attribute the symptoms of concussion to a process exclusively involving the brain.[6] Symptoms of concussion and whiplash-associated disorders such as headache, neck pain, disturbance of concentration or memory, dizziness, irritability, sleep disturbance, and fatigue have been described in both patients with concussion[21] and whiplash.[22] Thus, nonspecific symptoms such as headache, dizziness, or fatigue can be used to support the diagnosis of concussion but should not definitively establish a diagnosis of concussion based on their appearance alone. The Veterans Affairs and the American Department of Defense state that the symptoms associated with concussion/mild traumatic brain injury occur frequently in day-to-day life among healthy individuals and are highly subjective in nature.[23]

Neck injuries, including contusion or sprain, have an incidence of 2.6% to 7.5% in contact sports and can occur simultaneously with head injury in the athlete.[24,25] Symptoms of neck injury have been shown to closely mimic those of head injury in athletes.[26] Hynes et al,[27] for example, found a strong association between whiplash-induced neck injuries and the symptoms of concussion in hockey players. Cervical injuries alone, or in combination with head injury, can cause persistent dizziness and balance difficulties, result in continuing headaches, and increase the risk of PCD.[28–31] Isolated chronic neck injuries can result in headaches, dizziness, unsteadiness, visual disturbances, and poor postural control.[9,32] It is possible that the symptom overlap between whiplash and concussive injuries is related to rotational forces imparted to the head and neck during head injury, with effects on nerve tracts in the brain as well as on the proprioceptive fibers in the cervical soft tissues.[26,33] Other possible sources of cervical symptoms include the cervical zygoapophyseal joints, which may cause headache and dizziness in patients with whiplash.[34]

A careful physical examination of the cervical spine and a neurologic examination focusing on the vestibular system and oculomotor responses can help identify sources other than brain concussion that produce similar symptoms.[35] Abnormal findings on examination of the cervical region may indicate that a neck injury is the source or a contributor to symptoms yet there is no standardized evaluation of the neck for patients who have sustained a concussion. Impairments in

position sense have been observed in patients with whiplash-type injuries and in individuals with chronic head and neck pain of nontraumatic origin (eg, cervical spondylosis).[26] Armstrong et al[26] provide an excellent review of the pathophysiology of cervical proprioception and its role in neck injury and continued disequilibrium. Accurate and early detection of concomitant neck injury and/or vestibular/ocular abnormalities in concussed patients could allow for the appropriate prescription of cervical spine and vestibular therapy, which has the potential to reduce symptoms and speed recovery.[36] Furthermore, the management of neck injury includes encouraging patients to engage in their regular daily activities, even in the presence of symptoms.[6] The recognition of whiplash injury and other treatable conditions as part of the concussion syndrome would move treatment guidelines away from strict rest-based protocols and the disability that they have the potential to perpetuate.[37]

Limitations of this study include that it is retrospective and the sample size may be too small for the types of analysis included. Formal neuropsychological testing of cognition was not performed and may have improved the discriminant potential of cognitive variables. Instead, we were limited to 4 cognitive symptoms on the self-report scale. Furthermore, despite the fact that the Zurich Guidelines state that exercise intolerance indicates lack of recovery from concussion,[1] exercise intolerance has not been proven definitively to differentiate concussion from other disorders. Prospective studies of patients with head injury should attempt to define unique patient cohorts based on physiological and physical examination findings to better classify patients for therapeutic and research purposes.

In conclusion, the results of this study show that symptom reports from patients with delayed recovery after head injury, including cognitive symptoms, do not discriminate between those with a physiologic PCD and those with a cervical/vestibular injury. The nonspecificity of symptoms after head injury means that clinicians should perform a careful physical examination of the cervical spine and of the vestibular/ocular systems and may also wish to use specific testing of exercise tolerance to better determine the etiology of postconcussion symptoms so that proper therapy can be directed to the causative condition(s).

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The Sport Concussion Assessment Tool 5th Edition (SCAT5)

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ABSTRACT

This paper presents the Sport Concussion Assessment Tool 5th Edition (SCAT5), which is the most recent revision of a sport concussion evaluation tool for use by healthcare professionals in the acute evaluation of suspected concussion. The revision of the SCAT3 (first published in 2013) culminated in the SCAT5. The revision was based on a systematic review and synthesis of current research, public input and expert panel review as part of the 5th International Consensus Conference on Concussion in Sport held in Berlin in 2016. The SCAT5 is intended for use in those who are 13 years of age or older. The Child SCAT5 is a tool for those aged 5–12 years, which is discussed elsewhere.

INTRODUCTION

The Concussion In Sport Group (CISG) developed the Sport Concussion Assessment Tool (SCAT)[1] during the 2004 meeting in Prague to serve as an educational tool for the public and to assist medical providers in evaluating sports-related concussion (SRC). The SCAT combined previously separate approaches to the assessment of symptoms (graded symptom checklist), cognitive status (five-word immediate recall, delayed recall, Maddocks questions)[2] and gross neurological functioning (speech, eye motion and pupil reaction, pronator drift and gait assessment; all assessed as 'pass' vs 'fail').

The SCAT was revised in 2008 and the new version, the SCAT2,[3] was based on a review of the empirical literature at the time. The SCAT2 comprised eight subscales that assessed symptoms (Graded Symptom Checklist—Total Symptoms, Symptom Severity),[4] physical signs score, cognitive functioning (Standardized Assessment of Concussion (SAC),[5] Maddocks questions,[2] balance (modified Balance Error Scoring System (mBESS),[6 7] the Glasgow Coma Scale (GCS),[8] delayed word recall and a brief coordination examination. The subscales could each be scored independently and summed for a maximum total score of 100. The SCAT2 was designed for use by medical practitioners. The Pocket SCAT2, a separate tool, was developed for use by non-medically trained individuals.

The SCAT2 was revised in 2012 as part of the 4th International Consensus Conference on Concussion in Sport in Zurich,[9] following a systematic review of the scientific literature by Guskiewicz *et al*,[10] culminating in a new version, the SCAT3. In addition, a new tool for children (under the age of 13) called the Child-SCAT3 was developed. The components of the SCAT3 include: indications for emergency management, potential signs of concussion, GCS, Maddocks questions, medical background questions, symptom evaluation, cognitive assessment, neck examination, balance examination, coordination examination,[11] considerations for management and concussion advice. The SCAT3 removed the total/composite score of the SCAT2 since there was no evidence for its validity, but retained scoring of the individual subscales. Other improvements included the addition of several 'visible' or 'observable' signs of concussion and the option of using a more sensitive 'foam' component of the full BESS.[6 7] A timed tandem gait test was also added as an alternative to the mBESS[11 12]. Additional information was added to the 'Concussion injury advice' section.[10] A separate Concussion Recognition Tool (CRT) was also developed in place of the pocket SCAT to provide information to non-medical personnel regarding the importance of recognition and removal from play of athletes suspected of SRC.

METHODS

The CISG met in Berlin in 2016 at the Fifth International Consensus Conference on Concussion in Sport. The meeting methods are detailed elsewhere[13]. The consensus process followed the approach previously employed by the CISG, which included the development of 12 questions that were to be addressed by systematic reviews in advance of the meeting, an open forum for presentation and discussion, followed by an expert panel meeting. A subset of the expert panel met on a separate day to make recommendations for improving the SCAT following examination of the results of the SCAT systematic review and reports/observations of professionals who use the tool clinically.

The SCAT5 systematic review[14] consisted of five different but inter-related searches covering: (1) adult SCAT; (2) child SCAT; (3) sideline assessment; (4) video surveillance/observable signs of concussion and (5) oculomotor assessment. The present paper will only focus on the SCAT5 (for athletes aged over 12 years). The Child-SCAT5 (for younger athletes) is published separately in this issue.[14]

Linked

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RESULTS

The SCAT5 systematic review[14] concluded that studies employing the SCAT (all forms) or its components generally had a low to moderate levels of bias and were generalisable to the larger population, although variability was noted in methodologies, risk of bias, quality of evidence and presentation of data. Overall, the graded symptom checklist, SAC and BESS/mBESS were found to be most useful immediately postinjury in differentiating concussed from non-concussed athletes when using either intraindividual or normative baseline/postinjury comparisons. The diagnostic utility of the SCAT and its components appears to decrease significantly after 3–5 days postinjury, which suggests that the tool may have differential utility in helping to diagnose concussion and tracking recovery versus assisting return to play decision making.[15] As such, the tool appears to be clinically useful in screening evaluations and making the diagnosis of SRC but has a more limited role in tracking recovery and assisting the return to play/sport decision. The symptom checklist does demonstrate clinical utility in tracking recovery.

A notable limiting factor for the SCAT was evidence of a ceiling effect on the SAC portion for adolescents and adults. Specifically, ceiling effects were apparent on the Immediate Recall subcomponent of the SAC.

Although possibly a result of the search strategy, there were limited data that examined the utility of the SCAT across different cultural and linguistic groups.

THE SCAT5

The SCAT5 is a tool for use by healthcare professionals in the evaluation of individuals 13 years old or older, who are suspected of having sustained an SRC. The Child SCAT5 is used to evaluate SRC in children 5–12 years old.[14] A separate tool, the Concussion Recognition Tool 5 (CRT5),[16] was developed for use by non-medically trained individuals to assist in the identification and initial management of *suspected* SRC. The designation of the SCAT5 (rather than SCAT4) was chosen to align the version number with the fifth meeting of the CISG. There is no SCAT4.

In revising the SCAT, the expert panel was cognisant of the fact that the SCAT3 has been used widely across many different countries and a significant amount of normative data has been gathered. Similarly, healthcare professionals have generally found the SCAT3 to be useful and have become proficient in its administration. For these reasons, the modification of the SCAT3 into the SCAT5 was not only guided by information gathered in the systematic review, expert panel discussions and input from conference attendees but also with the understanding that the tool should maintain as much continuity as possible with the SCAT3 and should only be changed where necessary.

The modifications included in the SCAT5 are presented in box 1.

Box 1 SCAT5 modifications

- Declaration that the complete SCAT5 cannot be appropriately completed in less than 10 min.
- Inclusion of an Immediate/Acute Assessment section, including indications for emergency management and observable signs of possible concussion.
- Clarified instructions that the Symptom Checklist should be completed by the *athlete* in a *resting* state.
- Different instructions for completing the symptom checklist at baseline and postinjury have been added.
- Addition of questions that compare the athlete's postinjury presentation with preinjury behaviour.
- The SAC immediate and delayed word recall lists include an option to use 10 words instead of 5 to minimise ceiling effects.
- All six versions of the SAC word lists are now presented with alternate stimulus sets for the word list and digits backwards. Their administration should be randomised at baseline and serially postinjury.
- A notation of when the last trial of the word list was administered is required (the delayed recall should not be administered sooner than 5 min after the immediate memory subtest).
- Digits Backwards now contains six versions of the digit strings, which should be randomised at baseline and serially postinjury.
- A Rapid Neurological Screen has been included.
- A section has been added that includes affirmation that the SCAT5 was used or supervised by a healthcare professional and whether a concussion was diagnosed.
- The Instruction section has been enhanced to include all of the modifications described above.
- The Return to Sport progression emphasises that the initial period of physical and cognitive rest should typically only last 24-48 hours.
- A Return to School progression has been added, including possible academic accommodations.
- The SCAT5 specifically indicates that written clearance by a healthcare professional is necessary prior to returning to play/sport.

DISCUSSION

The SCAT5 continues the tradition of its predecessors by creating a standardised approach to acute evaluation of suspected concussion that includes measures and methods shown to be useful in detecting SRC. The SCAT5 maintains consistency with the SCAT3 wherever possible, although it does address some of the limitations identified in the systematic review and provides additional evaluative tools. For example, to increase the utility of the tool, a Rapid Neurological Screen has been included that consists of an evaluation of the cervical exam, athlete's speech, ability to read, balance, gait, visual tracking and finger to nose coordination. The Rapid Neurological Screen is a brief screening tool that does not replace a more complete examination.

The diagnosis of concussion relies on a clinical synthesis of complex, non-specific and at times contradictory information. Accordingly, only healthcare professionals trained in assessing and managing SRC should use the SCAT5, which is not designed to be used in isolation to make or exclude the diagnosis of concussion. The SCAT5 includes comprehensive instructions for the appropriate administration of the subscales that should be carefully studied and practised prior to clinical use.

The expert panel discussed the time necessary to administer the complete SCAT5 and consensus was reached that no less than 10 min were required. Those sports that allow only a limited amount of time of less than 10 min for an acute evaluation screening of suspected concussion are encouraged to review their existing rules if indicated. Since there did not appear to be any empirical evidence to support a specific time

frame (eg, 10 min), the SCAT5 does not specify any time frame between exercise and administration of the SCAT. However, there is expert consensus that the SCAT5 should be administered in a resting state, which means that the athlete should be at or near his or her resting heart rate. Anecdotal reports of athletes memorising and rehearsing words lists and digits are addressed with the provision of six distinct groups of five words and six sets of digit strings, which should be randomly presented at baseline and sequentially postinjury. The added option of using a 10-word list per trial could diminish ceiling effects, while preserving continuity with the 5-word list in those settings where ceiling effects are less apparent. As this is a novel methodology, normative data will need to be collected on the 10-word lists and research will be required to examine its utility.

The systematic review noted that there was scant information on the use of the SCAT in athletes with disabilities, as well as across different cultures and language groups. Indeed, much of the normative data that exist are limited to a few sports in North America. It is recommended that a systematic approach be undertaken to translate and culturally adapt the SCAT5 into a broad range of languages. Research is encouraged to establish a comprehensive set of norms across language groups, sports, gender, disabilities and age.

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The Sport Concussion Assessment Tool 5th Edition (SCAT5)

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Notes

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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

Name: _____

DOB: _____

Address: _____

ID number: _____

Examiner: _____

Date: _____

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.

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

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."

References

1. McCrory et al. Consensus Statement On Concussion In Sport – The 5th International Conference On Concussion In Sport Held In Berlin, October 2016. British Journal of Sports Medicine 2017 (available at www.bjsm.bmj.com)
2. Maddocks, DL; Dicker, GD; Saling, MM. The assessment of orientation following concussion in athletes. Clinical Journal of Sport Medicine 1995; 5: 32-33
3. Jennett, B., Bond, M. Assessment of outcome after severe brain damage: a practical scale. Lancet 1975; i: 480-484
4. McCrea M. Standardized mental status testing of acute concussion. Clinical Journal of Sport Medicine. 2001; 11: 176-181
5. Guskiewicz KM. Assessment of postural stability following sport-related concussion. Current Sports Medicine Reports. 2003; 2: 24-30

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.

Sport concussion assessment tool - 5th edition

Br J Sports Med published online April 26, 2017

Notes

BJSM Online First, published on April 26, 2017 as 10.1136/bjsports-2017-097492childscat5
To download a clean version of the SCAT tools please visit the journal online (http://dx.doi.org/10.1136/bjsports-2017-097492childscat5)

Child SCAT5©

SPORT CONCUSSION ASSESSMENT TOOL

FOR CHILDREN AGES 5 TO 12 YEARS

FOR USE BY MEDICAL PROFESSIONALS ONLY

supported by

Patient details

Name: _____

DOB: _____

Address: _____

ID number: _____

Examiner: _____

Date of Injury: _____ Time: _____

WHAT IS THE CHILD SCAT5?

The Child SCAT5 is a standardized tool for evaluating concussions designed for use by physicians and licensed healthcare professionals[1].

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

Preseason Child SCAT5 baseline testing can be useful for interpreting post-injury test scores, but not required for that purpose. Detailed instructions for use of the Child 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 the child is suspected of having a concussion and medical personnel are not immediately available, the child should be referred to a medical facility for urgent assessment.
- 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 Child SCAT5 should NOT be used by itself to make, or exclude, the diagnosis of concussion. An athlete may have a a concussion even if their Child 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

Name: _____

DOB: _____

Address: _____

ID number: _____

Examiner: _____

Date: _____

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 cervical spine exam is a critical step of the immediate assessment, however, it does not need to be done serially.

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: EXAMINATION
GLASGOW COMA SCALE (GCS)[2]

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
STEP 1: ATHLETE BACKGROUND

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

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: _____

Davis GA, *et al. Br J Sports Med* 2017;**0**:1–8. doi:10.1136/bjsports-2017-097492childscat5

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.

To be done in a resting state

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

Name: _____

DOB: _____

Address: _____

ID number: _____

Examiner: _____

Date: _____

2

Child Report[3]

	Not at all/ Never	A little/ Rarely	Somewhat/ Sometimes	A lot/ Often
I have headaches	0	1	2	3
I feel dizzy	0	1	2	3
I feel like the room is spinning	0	1	2	3
I feel like I'm going to faint	0	1	2	3
Things are blurry when I look at them	0	1	2	3
I see double	0	1	2	3
I feel sick to my stomach	0	1	2	3
My neck hurts	0	1	2	3
I get tired a lot	0	1	2	3
I get tired easily	0	1	2	3
I have trouble paying attention	0	1	2	3
I get distracted easily	0	1	2	3
I have a hard time concentrating	0	1	2	3
I have problems remembering what people tell me	0	1	2	3
I have problems following directions	0	1	2	3
I daydream too much	0	1	2	3
I get confused	0	1	2	3
I forget things	0	1	2	3
I have problems finishing things	0	1	2	3
I have trouble figuring things out	0	1	2	3
It's hard for me to learn new things	0	1	2	3
Total number of symptoms:				of 21
Symptom severity score:				of 63
Do the symptoms get worse with physical activity?			Y	N
Do the symptoms get worse with trying to think?			Y	N

Overall rating for child to answer:

	Very bad									Very good
On a scale of 0 to 10 (where 10 is normal), how do you feel now?	0	1	2	3	4	5	6	7	8	9	10

If not 10, in what way do you feel different?:

Parent Report

The child:

	Not at all/ Never	A little/ Rarely	Somewhat/ Sometimes	A lot/ Often
has headaches	0	1	2	3
feels dizzy	0	1	2	3
has a feeling that the room is spinning	0	1	2	3
feels faint	0	1	2	3
has blurred vision	0	1	2	3
has double vision	0	1	2	3
experiences nausea	0	1	2	3
has a sore neck	0	1	2	3
gets tired a lot	0	1	2	3
gets tired easily	0	1	2	3
has trouble sustaining attention	0	1	2	3
is easily distracted	0	1	2	3
has difficulty concentrating	0	1	2	3
has problems remembering what he/she is told	0	1	2	3
has difficulty following directions	0	1	2	3
tends to daydream	0	1	2	3
gets confused	0	1	2	3
is forgetful	0	1	2	3
has difficulty completing tasks	0	1	2	3
has poor problem solving skills	0	1	2	3
has problems learning	0	1	2	3
Total number of symptoms:				of 21
Symptom severity score:				of 63
Do the symptoms get worse with physical activity?			Y	N
Do the symptoms get worse with mental activity?			Y	N

Overall rating for parent/teacher/coach/carer to answer

On a scale of 0 to 100% (where 100% is normal), how would you rate the child now?

If not 100%, in what way does the child seem different?

STEP 3: COGNITIVE SCREENING

Standardized Assessment of Concussion - Child Version (SAC-C)[4]

Name: _____

DOB: _____

Address: _____

ID number: _____

Examiner: _____

Date: _____

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			
5-2	4-1	4-9	Y	N	0
4-1	9-4	6-2	Y	N	1
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			
2-7	9-2	7-8	Y	N	0
5-9	6-1	5-1	Y	N	1
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	4-2-7-3-9-8	3-1-7-8-2-6	Y	N	1
		Digits Score:			of 5

DAYS IN REVERSE ORDER

Now tell me the days of the week in reverse order. Start with the last day and go backward. So you'll say Sunday, Saturday. Go ahead.

Sunday - Saturday - Friday - Thursday - Wednesday - Tuesday - Monday	0 1
Days Score	of 1
Concentration Total Score (Digits + Days)	of 6

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 (BESS) 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, 10-12 y/o only)	of 10	
Tandem stance (non-dominant foot at back)	of 10	
Total Errors	5-9 y/o of 20	10-12 y/o 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 Child report (of 21) Parent report (of 21)			
Symptom severity score Child report (of 63) Parent report (of 63)			
Immediate memory	of 15 of 30	of 15 of 30	of 15 of 30
Concentration (of 6)			
Neuro exam	Normal Abnormal	Normal Abnormal	Normal Abnormal
Balance errors (5-9 y/o of 20) (10-12 y/o 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 Child SCAT5.

Signature: _____

Name: _____

Title: _____

Registration number (if applicable): _____

Date: _____

SCORING ON THE CHILD 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.

For the Neurological Screen (page 5), if the child cannot read, ask him/her to describe what they see in this picture.

Name: _____

DOB: _____

Address: _____

ID number: _____

Examiner: _____

Date: _____

CLINICAL NOTES:

Concussion injury advice for the child and parents/carergivers

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

This child has had an injury to the head and needs to be carefully watched for the next 24 hours by a responsible adult.

If you notice any change in behavior, vomiting, dizziness, worsening headache, double vision or excessive drowsiness, please call an ambulance to take the child to hospital immediately.

Other important points:

Following concussion, the child should rest for at least 24 hours.

- The child should not use a computer, internet or play video games if these activities make symptoms worse.
- The child should not be given any medications, including pain killers, unless prescribed by a medical doctor.
- The child should not go back to school until symptoms are improving.
- The child should not go back to sport or play until a doctor gives permission.

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 Child SCAT5 are the instructions given to the athlete by the clinician

Symptom Scale

In situations where the symptom scale is being completed after exercise, it should still be done in a resting state, at least 10 minutes post exercise.

At Baseline

- The child is to complete the Child Report, according to how he/she feels today, and
- The parent/carer is to complete the Parent Report according to how the child has been over the previous week.

On the day of injury

- The child is to complete the Child Report, according to how he/she feels now.
- If the parent is present, and has had time to assess the child on the day of injury, the parent completes the Parent Report according to how the child appears now.

On all subsequent days

- The child is to complete the Child Report, according to how he/she feels today, and
- The parent/carer is to complete the Parent Report according to how the child has been over the previous 24 hours.

For Total number of symptoms, maximum possible is 21

For Symptom severity score, add all scores in table, maximum possible is 21 x 3 = 63

Standardized Assessment of Concussion Child Version (SAC-C)

Immediate Memory

Choose one of the 5-word lists. 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.

OPTION: The literature suggests that the Immediate Memory has a notable ceiling effect when a 5-word list is used. (In younger children, use the 5-word list). 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.

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 only, from List A, B, C, D, E or F, and administer those digits as follows:

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

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.

Days of the week in reverse order

"Now tell me the days of the week in reverse order. Start with Sunday and go backward. So you'll say Sunday, Saturday ... Go ahead"

1 pt. for entire sequence correct

Delayed Recall

The delayed recall should be performed after at least 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."

Circle each word correctly recalled. Total score equals number of words recalled.

Neurological Screen

Reading

The child is asked to read a paragraph of text from the instructions in the Child SCAT5. For children who can not read, they are asked to describe what they see in a photograph or picture, such as that on page 6 of the Child SCAT5.

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

These instructions are to be read by the person administering the Child SCAT5, and each balance task should be demonstrated to the child. The child should then be asked to copy what the examiner demonstrated.

Each of 20-second trial/stance is scored by counting the number of errors. The This balance testing is based on a modified version of the Balance Error Scoring System (BESS)[5].

A stopwatch or watch with a second hand is required for this testing.

"I am now going to test your balance. Please take your shoes off, roll up your pants above your ankle (if applicable), and remove any ankle taping (if applicable). This test will consist of two different parts."

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).

(a) Double leg stance:

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

(b) Tandem stance:

Instruct or show the child how to stand heel-to-toe with the non-dominant foot in the back. Weight should be evenly distributed across both feet. Again, the child should try to maintain stability for 20 seconds with hands on hips and eyes closed. You should inform the child that you will be counting the number of times the child moves out of this position. If the child stumbles out of this position, instruct him/her to open the eyes and return to the start position and continue balancing. You should start timing when the child is set and the eyes are closed.

(c) Single leg stance (10-12 year olds only):

"If you were to kick a ball, which foot would you use? [This will be the dominant foot] *Now stand on your other foot. You should bend your other leg and hold it up (show the child). Again, try to stay in that position 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 move out of this position, open your eyes and return to the start position and keep balancing. I will start timing when you are set and have closed your eyes."*

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

Each of the 20-second trials is scored by counting the errors, or deviations from the proper stance, accumulated by the child. The examiner will begin counting errors only after the child has assumed the proper start position. The modified BESS is calculated by adding one error point for each error during the 20-second tests. The maximum total number of errors for any single condition is 10. If a child commits multiple errors simultaneously, only one error is recorded but the child should quickly return to the testing position, and counting should resume once subject is set. Children who 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.

Tandem Gait

Instruction for the examiner - Demonstrate the following to the child:

The child is 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. Children 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

The tester should demonstrate it to the child.

"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). 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 as quickly and as accurately as possible."

Scoring: 5 correct repetitions in < 4 seconds = 1

Note for testers: Children fail the test if they do not touch their nose, do not fully extend their elbow or do not perform five repetitions.

References

1. McCrory et al. Consensus Statement On Concussion In Sport – The 5th International Conference On Concussion In Sport Held In Berlin, October 2016. British Journal of Sports Medicine 2017 (available at www.bjsm.bmj.com)
2. Jennett, B., Bond, M. Assessment of outcome after severe brain damage: a practical scale. Lancet 1975; i: 480-484
3. Ayr, L.K., Yeates, K.O., Taylor, H.G., Brown, M. Dimensions of postconcussive symptoms in children with mild traumatic brain injuries. Journal of the International Neuropsychological Society. 2009; 15:19–30
4. McCrea M. Standardized mental status testing of acute concussion. Clinical Journal of Sports Medicine. 2001; 11: 176-181
5. Guskiewicz KM. Assessment of postural stability following sport-related concussion. Current Sports Medicine Reports. 2003; 2: 24-30

CONCUSSION INFORMATION

If you think you or a teammate has a concussion, tell your coach/trainer/parent right away so that you can be taken out of the game. You or your teammate should be seen by a doctor as soon as possible. YOU OR YOUR TEAMMATE SHOULD NOT GO BACK TO PLAY/SPORT THAT DAY.

Signs to watch for

Problems can happen over the first 24-48 hours. You or your teammate should not be left alone and must go to a hospital right away if any of the following happens:

- New headache, or headache gets worse
- Neck pain that gets worse
- Becomes sleepy/drowsy or can't be woken up
- Cannot recognise people or places
- Feeling sick to your stomach or vomiting
- Acting weird/strange, seems/feels confused, or is irritable
- Has any seizures (arms and/or legs jerk uncontrollably)
- Has weakness, numbness or tingling (arms, legs or face)
- Is unsteady walking or standing
- Talking is slurred
- Cannot understand what someone is saying or directions

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

Graduated Return to Sport Strategy

After a concussion, the child should rest physically and mentally for a few days to allow symptoms to get better. In most cases, after a few days of rest, they can gradually increase their daily activity level as long as symptoms don't get worse. Once they are able to do their usual daily activities without symptoms, the child should gradually increase exercise in steps, guided by the healthcare professional (see below).

The athlete should not return to play/sport the day of injury.

NOTE: An initial period of a few days of both cognitive ("thinking") and physical rest is recommended before beginning the Return to Sport progression.

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.	

There should be at least 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). The athlete should not return to sport until the concussion symptoms have gone, they have successfully returned to full school/learning activities, and the healthcare professional has given the child written permission to return to sport.

If the child has symptoms for more than a month, they should ask to be referred to a healthcare professional who is an expert in the management of concussion.

Graduated Return to School Strategy

Concussion may affect the ability to learn at school. The child may need to miss a few days of school after a concussion, but the child's doctor should help them get back to school after a few days. When going back to school, some children may need to go back gradually and may need to have some changes made to their schedule so that concussion symptoms don't get a lot worse. If a particular activity makes symptoms a lot worse, then the child should stop that activity and rest until symptoms get better. To make sure that the child can get back to school without problems, it is important that the health care provider, parents/caregivers and teachers talk to each other so that everyone knows what the plan is for the child to go back to school.

Note: If mental activity does not cause any symptoms, the child may be able to return to school part-time without doing school activities at home first.

Mental Activity	Activity at each step	Goal of each step
1. Daily activities that do not give the child symptoms	Typical activities that the child 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 child continues to have symptoms with mental activity, some other things that can be done to 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 child 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.

Sport concussion assessment tool for childrens ages 5 to 12 years

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Notes