



Review of the current side-line methods used to detect concussion in sport settings

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PLAIN LANGUAGE SUMMARY

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Review question

What are the current side-line screening methods used to establish the diagnosis of acute concussion or suspected concussion across sports in an adult population?

Background

What is a concussion?

A concussion is a mild form of traumatic brain injury (TBI) that may alter how the brain works and can temporarily disrupt functions such as concentration, balance, memory, and coordination. A loss of consciousness, however, occurs only in 10-15% of all concussions. A concussion results from a direct or an indirect impact, for example a fall or accidental collision during sport or recreational activities. These impacts can cause the brain tissue to move inside the skull due to sudden acceleration or deceleration of the head. Following an impact, like a collision or tackle on the field, a concussed athlete may display visible signs of injury that parents, coaches, and trainers can observe, along with symptoms they feel or experience that may not be as obvious.

What are the signs and symptoms of concussion injuries?

Concussion symptoms may affect physical, cognitive, and emotional functions. Early-onset symptoms can appear immediately, while other symptoms may emerge gradually. Some people may not fully acknowledge the symptoms or confuse them with something else.

Signs of concussion range from obvious to extremely subtle; however, no matter what symptoms present after an impact to the head or body, they require immediate reporting. Signs of a concussion can include headache, blurred vision, dizziness, nausea or vomiting, sensitivity to light or noise, balance problems, and fatigue. In addition, the person may display erratic emotions such as sadness, irritability, and/or anxiety.

Who do concussions affect?

Concussion injuries can occur in team sports or individual sports. In many team sports such as rugby, soccer, American or Australian Football, or Gaelic sports concussions usually occurs when opponents are contesting the ball involving accidents (such as collisions) or intentional acts (such as bumping or tackling) during game play. In individual sports such as boxing or martial arts and other combat sports where punching and kicking occurs, concussions are part of the risk of participation in the sport. Concussions may also occur during recreational activities such as cycling, skateboarding or surfing. As many

concussions are not easy to detect and identify, people risk getting injured and reinjuring themselves, which are suggested to increase risk in long term health effects such as difficulty concentrating or sleep disturbances. Therefore, early detection and identification of concussion is essential (Romeu-Mejia et al., 2019; Barrett et al., 2014; Giza et al., 2013).

How are concussions managed?

Concussions can go undetected, particularly at pitch-side in community or amateur sports. As a first step, the person suspected of having a concussion should be removed from play or activity. This should be followed by immediate medical attention whereby a concussion assessment should be administered by a suitably trained person.

In elite sports, many head injury assessments (HIA) are administered by a medical professional (e.g., Sport Concussion Assessment Tool 5 (SCAT5)). Generally, this type of HIA is not possible in non-elite settings (amateur or community sports). In many situations, clubs and organisations have limited resources with little access to medically trained personnel to administer a HIA. In many of these settings, subtle concussion symptoms could go undetected. However to date, it is not known what levels of sport HIAs are being administered. Consequently, if studies are only being performed at the elite level, there is a need for better detection methods to ensure correct management of concussion at non-elite settings, which was the aim of this review.

Review Methods

Electronic databases were used to search medical and scientific literature published from 01 January 2015 to 01 July 2020. These studies included research from professional sports, semi-professional sports, and data from amateur athletes. For the papers to be included, participants needed to have sustained a sports-related concussion (SRC) and be assessed within seven days of their injury. Tests must have been administered and performed at the 'pitch-side' or in areas immediately available that were not in a scientific or hospital/medical setting.

Study characteristics

Included studies, between 2015 and 2020, reported side-line assessments to diagnose concussion injuries in sport settings in a range of countries. There were 25 studies, which included a total of 7126 athletes (77% were male and 23% female) that were measured at baseline and post-concussion (76%) or at post-concussion timepoints only (23%).

Main results

A wide variety of assessments was used to identify and diagnose concussion injuries in athletes pitch-side. Cognitive testing, for reaction time, memory and concentration, was most commonly used (56%), followed by observation (8%), visual eye movement testing (8%), and a combination of all three (8%). Athletes played a variety of sports, 56% were professional or semi-professional and had access to trained medical personnel. In contrast, 36% of athletes played at amateur or community level and had an increased likelihood of limited medical resources. Overall, the majority of assessments were performed by medical personnel (88% - doctors, clinicians, orthopaedic support, neurologists, or with the assistance of certified athletic trainers or physiotherapists). The remainder were non-medical trained personnel.

Conclusions

Cognitive tests, such as the King Devick (KD) and the SCAT5 (administered by a medical professional) were the most widely used at pitch-side settings. These tests were most effectively used in combination with additional tests such as the observational Balance Error Scoring System ((BESS) requires training), and Vestibular/Ocular Motor Screening ((VOMS) administered by a medical professional) tests.

However, many of the studies included in this review (33%) were conducted at non-elite levels (amateur and community sport). This is primarily due to a shortfall of trained personnel who can administer HIA as most pitch side assessments require specialist training. This creates obstacles to a more comprehensive assessment and pitch-side management of concussed players in amateur and community sport.

Assessments which require specialist training cannot be performed at non-elite levels where access to medical resources or trained personnel may be limited. In conclusion, the focus of research and education needs to transfer to those who coach and manage non-elite athletes and non-elite sports as this is where the majority of concussions occur but is not being sufficiently researched at present.

How up to date is this evidence?

Electronic databases were used to search medical and scientific literature published from 01 January 2015 to 01 July 2020.

Main finding summary

Table 1.1 - Tests and screening methods used to diagnose concussion injuries at a pitch-side setting.

Test Type	Test Used
Cognitive	<ul style="list-style-type: none">• KD: King-Devick• SCAT 5: Sports Concussion Assessment Tool - version 5• SCAT 3: SCAT - version 3• SCAT 2: SCAT - version 2• SCA: Standardised Assessment of Concussion• ImPACT: Immediate Post-concussion Assessment Cognitive Testing• BSI: Brief Symptom Inventory-18• PSCA: Pitch Side Concussion Assessment• PSCA-2: Pitch Side Concussion Assessment (version 2)• PCSS: Post-Concussion Symptom Scale• CogSport (Cognitive Function Test)• MCTB: Motor Cognitive Test battery
Observation	<ul style="list-style-type: none">• BESS: Balance Error Scoring System• mBESS: modified Balance Error Scoring System• TG: Tandem Gait• BTBT: BTrackS Balance Test• VA: Video Assessment
Visual	<ul style="list-style-type: none">• VOMS: Vestibular/Ocular Motor Screening• MULES: Mobile Universal Lexicon Evaluation System• GI: Gait Initiation

Table 1.2 - Included studies in the systematic literature review, concussion assessment, sport and test administrator.

Author (Year)	Cognitive Test	Observational Test	Visual Test	Test Time Post Concussion	Sport	Sports Level	Who Administered Test
Broglia et al. (2019)	SCAT5, SAC, ImPACT, SCA, BSI-18	BESS	VOMS	3 times in 72hours (h): 0–1.25 h (side-line), 1.25–24 h (post-event), 24–72 h (clinic)	NCAA (sport unspecified)	Amateur	Medical staff
Buckley et al. (2017)			GI	24 hours	NCAA (sport unspecified)	Amateur	Certified athletic trainer and the diagnosis was confirmed by a physician
Downey et al. (2018)	SCAT3			3 to 5 days (acute), 3 weeks (post-acute)	Football, rugby, ice hockey, soccer, lacrosse, basketball, volleyball, field hockey, baseball, wrestling	Amateur	Research coordinator trained to administer the instrument
Fallon et al. (2019)	SCAT3		MULES	Side-line	Ice hockey, soccer, football	Mixed: professional, amateur, semi professional	Team members
Fuller et al. (2017)	SCAT3			After game of injury	Rugby	Professional	Clinician
Fuller et al. (2015)	PSCA			Side-line (Time frame not stated)	Rugby	Professional	Team physiotherapist or physician
Fuller et al. (2019)	KD			48 hours	Rugby	Professional	Team doctor
Galetta et al. (2015)	KD, SAC	TG		Side-line/ rink-side (Time frame not stated)	Ice hockey, lacrosse	Amateur	Trained volunteers or by athletic trainers

Table 1.2 - Included studies in the systematic literature review, concussion assessment, sport and test administrator.

Author (Year)	Cognitive Test	Observational Test	Visual Test	Test Time Post Concussion	Sport	Sports Level	Who Administered Test
Gardner et al. (2017)		VA		N/A	Rugby league	Professional	Trainer or team medical staff
Goble et al. (2016)		BBT		48 hours	College athletes- (unspecified)	Amateur	Certified athletic training staff
Graves et al. (2016)	SOT	BESS		1-14 days	Football	Amateur	Team physicians (internal medicine, orthopaedic or neurologist or all)
Hanninen et al. (2018)	SCAT3			24 hours	Ice hockey	Professional	Medical staff
Harrold et al. (2017)	KD, SCAT3			N/A	Sport, other	N/A (patients at concussion centre gave consent to obtain data from)	Physician
Hecimovich et al. (2018)	KD			10-20 min post-game	Australian football	Professional	Medically trained person
King et al. (2015)	KD, SCAT3			Days 3, 7, 14, and 21 post injury	Rugby	Amateur	Physicians
Leong et al. (2015)	KD, SCAT2			N/A	Football, basketball	Professional and Amateur	Medical practitioner
Marinides et al. (2015)	KD, PCS, SAC, ImPACT	BESS		87 mins	Football, lacrosse, soccer	Amateur (collegiate athletes)	Athletic trainers or team physicians,
Merritt et al. (2015)	PCSS, ImPACT			Days 2, 7, and 14 post injury	Football, basketball, ice hockey, soccer, lacrosse, wrestling, other	Amateur	Athletic trainers or team physicians,

Table 1.2 - Included studies in the systematic literature review, concussion assessment, sport and test administrator.

Author (Year)	Cognitive Test	Observational Test	Visual Test	Test Time Post Concussion	Sport	Sports Level	Who Administered Test
Molloy et al. (2017)	KD, PSCA2, CogSport			48 hours	Rugby	Semi-professional	Team doctor or physiotherapist
Oldham et al. (2018)		TG, BESS, mBESS		< 48 hours	NCAA student-athletes	Amateur	Certified athletic trainer and diagnosed by the team physician.
Putukian et al. (2015)	SCAT2			0.52 ± 1.18 days	Football, rugby, volleyball, football, crew	Amateur	Physician
Russell-Giller et al. (2018)	KD		VOMS	72 hours	Sports (unspecified), other	N/A (review of patient reports who gave consent to obtain data)	Physician
Seidman et al. (2015)	KD, SCAT3			SAC, BESS: 24 to 48 hours, ImPACT: 5 to 7 and 10 to 14 hours	Football, soccer, volleyball, basketball, wrestling, ice hockey, softball	Amateur	Athletic trainers, physicians, scientists and medical students,
Sufrinko et al. (2017)	ImPACT, SAC	BESS		Days 3, 7, 14, and 21 post injury	Rugby	Amateur	Physician, neuropsychologist, certified athletic trainer
Vartiainen et al. (2016)	SCAT3, MotCoTe			87 mins	Football, lacrosse, soccer	Professional	Neurologist

KD: King Devick test, GI: Gait Initiation, SOT: Sensory Organization, TG: Tandem Gait, GT: Gait Termination MULES: Mobile Universal Lexicon Evaluation Systems, PSCA: Pitch-Side Concussion Assessment Version 1, PSCA2: Pitch-Side Concussion Assessment Version 2, MotCoTe: Motor Cognitive Test Battery, VOMS: Vestibular/Ocular Motor Screening, SCAT2: Sport Concussion Assessment Tool Version 2, SCAT3: Sport Concussion Assessment Tool Version 3, SCAT5: Sport Concussion Assessment Tool Version 5, ImPACT: Immediate Post-Concussion and Cognitive Testing, SAC, standardized assessment of concussion; PCSS: Post-Concussion Symptom Scale, VA: Video Assessment, BESS: Balance Error Scoring System, mBESS: modified Balance Error Scoring System, MotCoTe: Motor Cognitive Test battery, PCS, prospective cohort study; RCS, retrospective cohort study

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