mTBI, CTE, and CTDE – What is new, what is old?

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Disclosure Statement

I, Laurel Rudolph, MD, do not have any relevant financial interest or other relationship(s) with a commercial entity producing health care related product and/or services.

Objectives

- To enhance awareness of suggested guidelines for the acute evaluation of a concussion in the pediatric population.
- Learn the role of the 2016 Berlin guidelines in evaluation and management of pediatric concussions.
- To expand knowledge about concussion (mTBI) evaluation and management of student-athletes in the acute setting.
- To clarify what is "myth" about concussions, review current data, and discuss the evolving changes in evaluation and management of mTBIs.
- Define the role of vestibular/ocular testing in the acute evaluation and office management of pediatric concussions.
- Learn the current guidelines in regard to return-to-school and return-to-play for student-athletes diagnosed with a concussion.

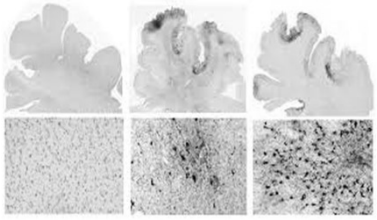
Terms

- mTBI –mild traumatic brain injury
  - Often used interchangeably with concussion; vague and not based on validated criteria
- Is a concussion part of a TBI spectrum?
- CTE-Chronic Traumatic Encephalopathy
  - CTE-degenerative brain disease found in athletes , military veterans, and others with a history of repetitive brain trauma
    - Tau protein forms clumps that slowly spread throughout the brain

Terms

CTE

- Sx: behavioral problems, mood problems, problems with thinking
- Tau protein



CTDE

- Changing Terms, Definitions, Ever Evolving
- Crazy Teens, Demonic Elders

Sports Related Concussion (SRC) Definition

(modified from 2000)

- A traumatic brain injury induced by biomechanical forces.

Berlin Consensus Statement on Concussion in Sport

- Developed by CISG (Concussion in Sport Group)
- Goal is to build on principles outlined in previous statements (2001, 2005, 2008, 2012) utilizing an expert consensus-based approach
- The science of SRC (Sport-Related Concussion) is evolving
- **INDIVIDUAL management** and return-to-play decisions remain in the realm of clinical judgement

McCrory, P. Meeuwisse w. et al. Consensus statement on concussion in sport – the 5th international conference on concussion in sports held in Berlin, October 2016. *Br. J Sports Med. 2017; 0: 1-10.*

SRC Common Features

- Caused by direct blow to the head, face, neck or other part of the body with an impulsive force transmitted to the head
- Typically results in rapid onset of short-lived impairment of neurological function that resolves spontaneously; signs & symptoms may evolve over minutes to hours
- Reflects a functional disturbance rather than a structural injury; no abnormality seen on standard structural neuroimaging studies
- Range of clinical signs & symptoms that may or may not involve LOC
- Resolution of clinical & cognitive features typically follows a sequential course. Some cases, symptoms may be prolonged.

Field Assessment & Management (NCAA)

- **A** Airway Maintenance w/ Cervical Spine Protection
- **B** Breathing and Ventilation
- **C** Circulation with Hemorrhage Control
- **D** Disability (Neurologic Evaluation)
- **E** Exposure and Environment

Sideline Evaluation

- Majority of SRCs occur without LOC or neurological signs
- One of the most complex injuries in sports medicine to diagnosis, assess & manage
- No perfect test or marker for immediate diagnosis

Field Assessment of the Concussed Athlete

- Interpreting the presence or absence of symptoms can be difficult
  - Symptoms because of fatigue, heat, illness
  - Part of season
- Athletes with hx/o concussion report larger number of symptoms
- No baseline available
- Not injured but have symptoms (mean score 3.52 for men, 6.39 for women)

Field Evaluation of the Concussed Athlete

- Initial Screening and Assessment
  - Evaluate for cervical spine injury or serious brain injury (intracranial bleed, skull fracture
- If conscious, assess athlete's orientation and both immediate & remote memory
  - Does athlete remember the play? Venue? How s he/she processing info?
  - Know rules of sport (time allowed for assessment, substitution)
- Signs and Symptoms
  - Graded Symptom Checklist-accurately identifies SRC with sensitivity 64-89%, specificity 91-100%

Graded Symptom Scale Checklist

Modified from various published symptom checklists[27-30]

Evaluate all signs and symptoms, ranking each on a scale of 0-6. **Establish baseline score prior to the start of the athletic season.** After a concussive injury, re-assess the athlete for each symptom. Add columns and compare to baseline score. Only consider return to activity if scores are comparable to baseline score. Continue testing every 2-3 days if symptoms do not resolve. Use with SAC and/or BESS to determine appropriate time for return to play.

	None			Moderate			Severe
Score According to Severity	0	1	2	3	4	5	6

Symptom	Preseason Baseline	Time of Injury	24 Hours Post-Injury	Day 3 Post-Injury	Day 4 Post-Injury	Day 5 Post-Injury
Blurred Vision						
Dizziness						
Drowsiness						
Sleeping More than Usual						
Easily Distracted						
Fatigue						
Feeling "In a Fog"						
Feeling "Slowed Down"						
Headache						
Unusually Emotional						
Irritability						
Loss of Consciousness						
Loss of Orientation						
Memory Problems						
Nauseous						
Nervousness						
Personality Changes						
Poor Balance/Coordination						
Ringing in the Ears						
Sadness						
Seeing Stars						
Sensitivity to Light						
Sensitivity to Noise						
Sleep Disturbances						
Vacant Stares/Glassy Eyes						
Vomiting						
TOTAL SYMPTOM SCORE:						

- Cognitive Tests:
  - SAC
  - Balance Assessment
  - Child SCAT for children age 5 to 12 years
  - SCAT 5
  - VOMS
  - King-Devick test –visual scanning ability decreases with concussion
  - Reaction time – measuring stick attached to hockey puck
- Head-Impact Sensors:
  - Lack of correlation between absolute impact magnitude and likelihood of concussion

Sideline Evaluations

- Rapid screening is important with removal of athlete from play
- Need to perform more thorough diagnostic exam in quiet environment
- Serial evaluations as symptoms may have delayed onset

SCAT 5

- Most well-established and rigorously developed instrument for sideline assessment
- Usefulness decreases significantly 3-5 days after injury

Sideline Evaluation

SCAT5® SPORT CONCUSSION ASSESSMENT TOOL – 5TH EDITION

DEVELOPED BY THE CONCUSSION IN SPORT GROUP

FOR USE BY MEDICAL PROFESSIONALS ONLY

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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.

This tool may be freely copied in its current form for distribution to individuals, teams, groups and organizations. It should not be altered in any way, re-branded or sold for commercial gain. Any revision, translation or reproduction in a digital form requires specific approval by the Concussion in Sport Group.

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

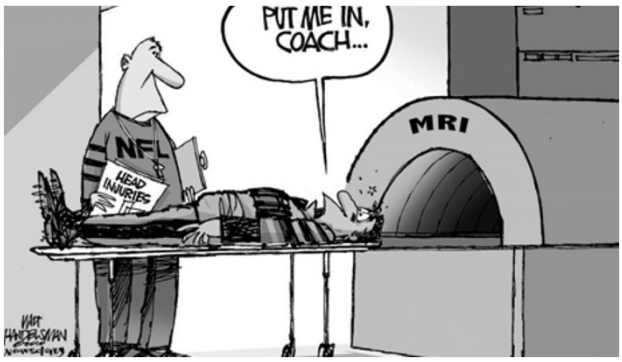
- Any athlete with suspected concussion should be REMOVED FROM PLAY, medically assessed and monitored for deterioration. No athlete diagnosed with concussion should be returned to play on the day of injury.
- If an athlete is suspected of having a concussion and medical personnel are not immediately 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.

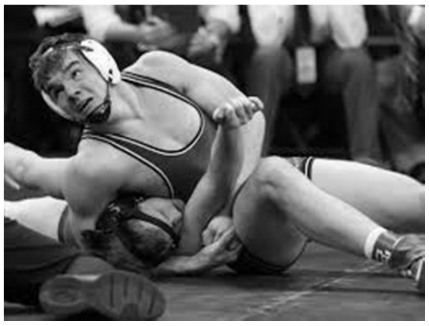
Echemendia RJ, *et al*. Br J Sports Med 2017;51:848–850. doi:10.1136/bjsports-2017-097506SCAT5

Sideline Evaluation



Summary

- Sideline assessment of the athlete is complex!
- Clinical impression remains criterion standard
- Examiner should feel comfortable when applying clinical suspicion to overrule a “negative” or “normal” result
- Familiarity with athlete is beneficial (licensed athletic trainers, coach, parent, teammate)
- Decision for return-to-play based on athlete safety, NOT scoreboard, position, senior year, regional, sectional, State



11 R's of Sport-Related Concussion Management

- Recognize
- Remove
- Re-evaluate
- Rest
- Rehabilitation
- Refer

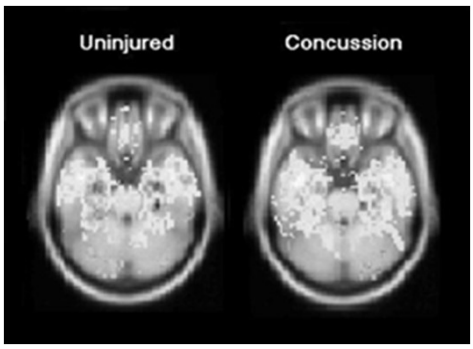
11 R's

- Recover
- Return to sport
- Reconsider
- Residual effects and sequelae
- Risk reduction

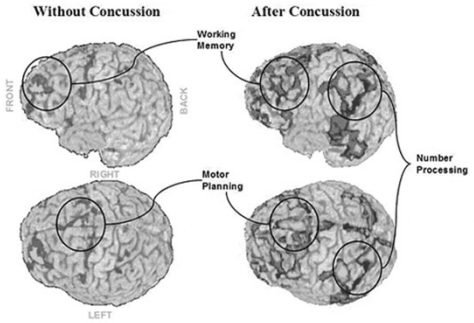
Diagnosis of SRC

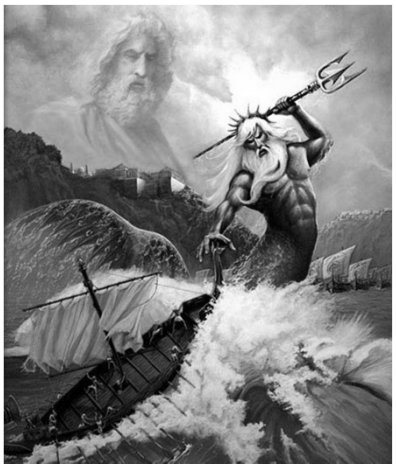
- **Symptoms**: somatic, cognitive, and/or emotional
- **Physical Signs**: LOC, amnesia, neurological deficit
- **Balance impairment**: gait unsteadiness
- **Behavioral changes**: irritability
- **Cognitive impairment**: slowed reaction times
- **Sleep/wake disturbance**: somnolence, drowsiness

Sport related concussion – functional NOT structural



Sports related concussion -myths





Sports related concussion - myths

SRC myths

- LOC
- Part of body impacted
- Severity of contact
- Mouthguards
- Frequently wake athlete

SRC - reality

- Second Impact syndrome
- Post concussion syndrome
- Female athletes take longer for recovery
- Genetics
- NO same day return to play
- Long term learning disability

Blood test for concussion?

- Use of CT scans in the U.S. between 1980 and 2017 has increased from 3 to 62 million with the head being the most commonly imaged
- Intracranial CT-positive trauma lesions were associated with ↑ GFAP (glial fibrillary acidic protein) in several studies
- GFAP can increase within hours of injury
- GFAP may be a potential screening for acute CT-detectable traumatic brain lesions
- Only 3 pediatric studies evaluating serum GFAP and traumatic brain lesions

11 R's of SRC Management

- Recognize
- Remove
- Re-evaluate
- Rest
- Rehabilitation
- Refer
- Recover
- Return to sport
- Reconsider
- Residual effects & sequelae
- Risk reduction

Re-evaluate

- Medical assessment with comprehensive history and detailed neuro exam to include: *mental status, cognitive functioning, sleep/wake disturbance, ocular function, vestibular function, gait & balance*
- Determination of clinical status whether improvement or deterioration since time of injury (speak with LATs, parents, coaches, teammates)
- Determination of need for emergent neuroimaging to exclude a more severe brain injury

History

- Mechanism of injury
- Helmeted sport?
- Mouthguard?
- LOC?
- Practice or competition
- Initial evaluation –what was done
- LAT present?
- Symptoms
- Was athlete removed from sport?
- Initial management
- Returned to school?
- Meds
- Sleep habits

Past Medical History

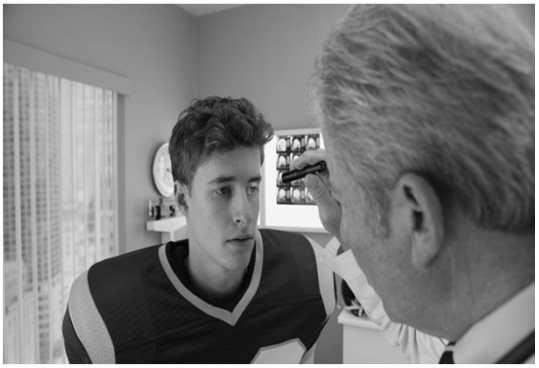
- Any previous concussion(s)
- Mechanism of concussion, time to return to school & sport
- Sequelae from previous concussion: symptoms, academic performance
- History of headaches
- ADHD
- Learning disorder
- Sleep hygiene
- Vision deficits
- LE injury/sequelae

Social History

- School, grade
- Academic performance
- Class schedule
- Sports played; number of years
- Position(s)
- Baseline neuropsych testing
- Resides with parents, siblings
- TV in bedroom
- Friends/social relationships

Physical Exam

- Observation: affect, posture, response
- Exam: HEENT, neck, spine, neuro, gait
- Balance
- Vestibular/Ocular motor screening (VOMS)



Concussion Related Visual Symptoms

- Headache
- Eyestrain
- Blurred vision
- Double vision
- Eye fatigue

Vestibular System

Balance

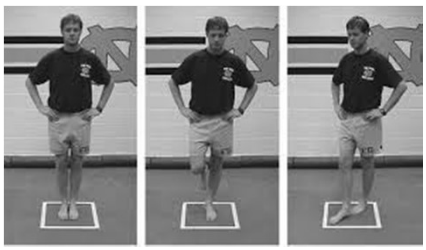
- Static symptom
- Dysfunction associated with the vestibulo-spinal component of the vestibular system
- BESS test

Ocular/Vestibular

- Dynamic symptoms such as dizziness and visual instability
- Dysfunction of the vestibulo-ocular component of the vestibular system

Balance Error Scoring System

- https://www.bing.com/videos/search?q=BESS+balance+test+utube&view=detail&mid=857A080AA02413F9EFE6857A080AA02413F9EFE6&FORM=VIRE



VOMS

- May consider pre-season to establish a baseline
- Administration time : 5-10 minutes
- Rate 4 symptoms before testing from 0-10, then after each test component.
- NPC distance is measured using average of 3 trials with values ≤ 5 cm considered normal.

Vestibular/Ocular Motor Screening (VOMS) for concussion

- Smooth pursuit – tests ability to follow a slow moving target
- Saccades (horizontal & vertical) – tests ability of eyes to move quickly between targets
- Vestibular ocular reflex (horizontal & vertical) – assess ability to stabilize vision as head moves

VOMS for concussion (cont'd)

- Visual motion sensitivity – tests visual motion sensitivity & ability to inhibit vestibular induced eye movements using vision
- Near point conversion (NPC) distance – measures ability to view a near target without double vision

VOMS

Table 1. Vestibular/Ocular Motor Screening (VOMS) for concussion[27]

VOMS Test	Headache[a]	Dizziness[a]	Nausea[a]	Fogginess[a]	Total Symptom Score[b]
Baseline symptoms					
Smooth pursuit					
Horizontal saccades					
Vertical saccades					
Near point convergence Measure 1: _____ Measure 2: _____ Measure 3: _____					
Horizontal VOR					
Vertical VOR					
Visual motion sensitivity					

VOR, vestibulo-ocular reflex.
[a]Provocation of symptoms is rated on a scale from 0 to 10, with 0 being no symptoms and 10 being severe symptoms.
[b]Total symptom score = change in headache from baseline + change in dizziness from baseline + change in nausea from baseline + change in fogginess from baseline for each of the VOMS test items.

Clinical Application of VOMS

- High sensitivity in identifying athletes who have sustained a sports-related concussion
- Relatively low rate of false-positives
- Study by Mucha et al. reported that > 60% of athletes with an SRC experienced symptom provocation on ≥1 VOMS items
- Studies have shown that female sex & a history of motion sickness are risk factors for VOMS scores above clinical cutoff levels in college athletes
- (Kontos, A, Sufrinko, A. Reliability and associated factors for performance on the vestibular/ocular motor screening (VOMS) tool in healthy collegiate athletes. *American Journal of Sports Medicine*. 2016; 44(6): 1400-1406.)

Near Point Convergence

- Binocular visual disturbances, such as NPC, found at higher rate (49%) among concussion patients compared to 2-8% in general population
- Most sx resolve in 10-14 days, but can take 4 weeks or longer

Story, Master, et al. Near point of convergence after concussion in children. Optometry and vision Science. January, 2017;94: 96-100

Abnormal Convergence

- Impact child's ability to return to educational setting, affecting near visual tasks such as reading, note taking
- PCSS not enough-test convergence
- School accommodations:
  - ↑ font size
  - Printed rather than electronic format
  - Auditory-based learning vs visual
- Patching-allows patients to read monocularly

Management of Concussions

- Re-evaluation may include computerized neuropsychological testing
- Baseline computerized NP testing not required but can be helpful
- NP testing should not be sole basis of management decisions
- Neuropsychologists have key role

Management of Concussions

- **Rest:** insufficient evidence that complete rest enhances recovery
- Rest during acute phase (24-48 hrs) after injury, then progress activity staying below cognitive and physical symptoms exacerbation thresholds
- **Rehabilitation**: psychological (mood or behavioral issues), cervical, vestibular rehab
- School accommodations, regular schedule
- **Refer:** 'persistent symptoms' defined as > 4 wks in children, >14 days in adults
  - No role for pharmacotherapy, EEG, advanced neuroimaging, biomarkers

Management of Concussions

- **Recovery**: Defined functionally as a return to normal activities, including school, work & sport
  - Large majority of athletes recover from a clinical perspective within 4 weeks. Neurobiological recovery may extend beyond one month in some athletes.
  - More literature demonstrating psychological factors affect symptom recovery and contribute to risk of persistent symptoms

Management of Concussions

- **Recovery**: Strongest & most consistent predictor of slow recovery from SRC is severity of initial symptoms.
  - Development of migraine headaches or depression are proven risk factors for extended recovery
  - LOC, amnesia – not proven to affect recovery
  - Past SRC –risk factor for future SRC?
- **Return to Sport**: graduated stepwise rehab

Management of Concussions

- **Reconsider**: No change in management for elite athletes
  - Child specific standards for SRC for children age 5-12
  - Adolescent specific paradigms for ages 13-18
- **Residual Effects & Sequelae:** literature is inconsistent
  - *A cause-and-effect relationship between SRCs and CTE has not yet been demonstrated*
- **Risk Reduction:** clinical history of SRCs, length of recovery, prevention

Concussion Prevention

Evidence

- Helmet use in skiing/snowboarding
- Elimination of body checking in youth hockey (under age 13)
- Red

Inconclusive

- Mouthguard use
- Limiting contact drills in youth football reduces frequency of head contact, not necessarily SRCs
- Tackling techniques in youth football, rugby

Summary

- Recommendations continue to evolve
- More research needed, especially in youth 5-12
- Symptoms vary between individual athletes, need individualized clinical approach!!!!! No definite recipe……
- Comprehensive, multi-faceted assessment
- Specific symptoms and impairments can be determined & info used to guide clinical management

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THANK YOU for your dedication to the EMS care of our youth, our future, and our communities!!!!