

Sports Related Concussion



BRIELLE
ORTHOPEDICS

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Sports Medicine

AT



ROTHMAN

Disclosure

- ▶ I have no affiliations and have nothing to disclose.

Objective

- ▶ Define concussion
 - ▶ Review the 2019 statement
 - ▶ Diagnosis
 - ▶ On field assessment

 - ▶ Management
 - ▶ Return to school and activity
- 

Definition

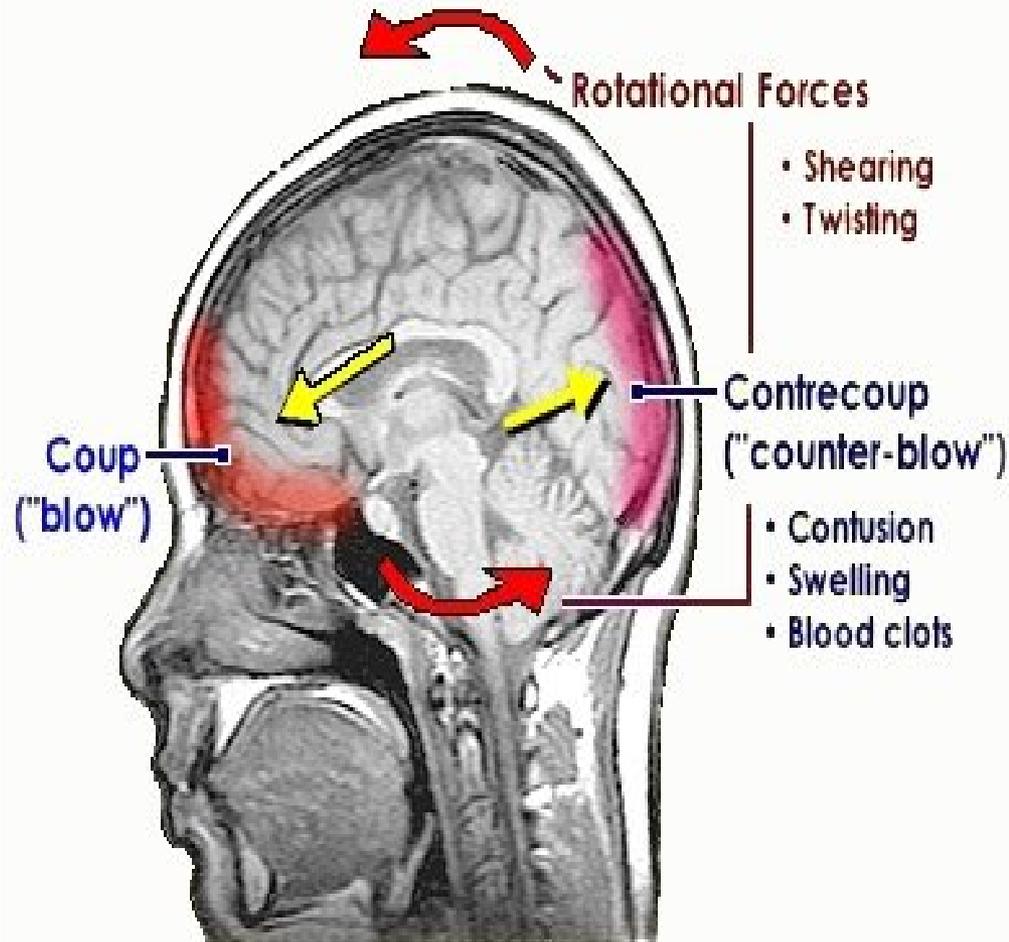
- ▶ A traumatically induced transient disturbance of brain function that involves a complex pathophysiological process.
- ▶ Subset of mild traumatic brain injury which is classified based on acute injury characteristics at the less severe end of the brain injury spectrum.
- ▶ The clinical signs and symptoms of concussion cannot be otherwise explained by drug, alcohol, medication use, or other injuries (such as cervical injuries or peripheral vestibular dysfunction) or other comorbidities (psychological or medical conditions).

Definition

- 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.
 - Whiplash, head snapping back against turf
- Typically results in the rapid onset of short-lived impairment of neurologic function that resolves spontaneously.
- The acute clinical symptoms largely reflect a functional disturbance rather than structural injury.
- Associated with grossly normal neuroimaging studies.

Concussion

- ▶ Due to:
 - Rotational
 - Shearing
 - Direct blow (coup)
 - Indirect blow (counter-coup)



Pathophysiology

- ▶ Brain trauma starts a biochemical cascade that disrupts the function of the brain cells
 - Glucose consumption increases
 - This increases lactic acid and decreases blood flow
- ▶ Brain cells not dead, but recovering, temporarily making them more vulnerable to injury
- ▶ Any further injury / insult during this period can result in cell death and worsening prognosis.

Concussion Guidelines

- ▶ 5th International Conference – Berlin 2016
- ▶ Gathering of concussion experts
- ▶ Consensus statement (BJSM)
 - Guidelines for concussion diagnosis, treatment and RTP protocol
 - SCAT5, Child SCAT5
- ▶ AMSSM 2019
 - Consensus Statement



Recognition of Concussion

- ▶ TEAM APPROACH
 - Athletic trainers
 - School Nurses
 - Team physician
 - Parents
 - Coaches
 - Players
 - Game Officials

Concussion Presentation

- ▶ Initial/On-field
 - +/- Loss of consciousness
 - Retro/anterograde amnesia
 - Not remembering plays
 - Not acting appropriately
 - Confused or Dazed
 - Headache, dizziness, blurry vision
 - Disorientation



Concussion Presentation

- ▶ After the fact
 - Confusion
 - Concentration difficulty
 - Recurrent headache
 - Slowed speech/comprehension
 - Sleep disturbance
 - Emotional lability

Physical Exam

- ▶ ABC' s
- ▶ Neck exam
- ▶ Neurologic exam
- ▶ SCAT testing

CONCUSSION



Red Flags – Signs of Emergency

- ▶ Fluctuating level of consciousness
- ▶ Unresponsive
- ▶ Persistent vomiting
- ▶ Severe progressive headache
- ▶ Breathing difficulties

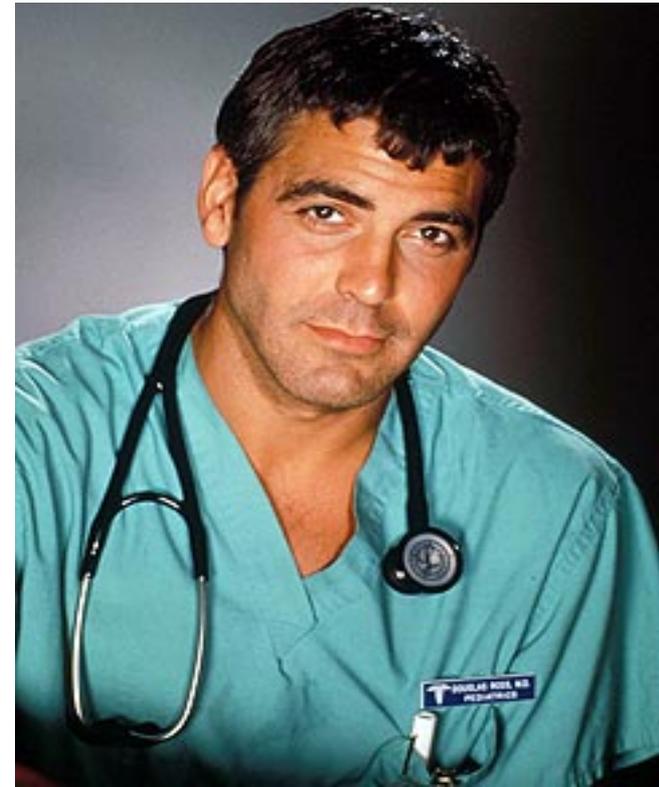


TABLE 38-2**Glasgow Coma Scale**

BEHAVIOR	RESPONSE	SCORE
Eye opening response	Spontaneously	4
	To speech	3
	To pain	2
	No response	1
Best verbal response	Oriented to time, place, and person	5
	Confused	4
	Inappropriate words	3
	Incomprehensible sounds	2
	No response	1
Best motor response	Obeys commands	6
	Moves to localized pain	5
	Flexion withdrawal from pain	4
	Abnormal flexion (decorticate)	3
	Abnormal extension (decerebrate)	2
	No response	1
Total score:	<i>Best response</i>	15
	<i>Comatose client</i>	8 or less
	<i>Totally unresponsive</i>	3

Ages 12 and Above

SCAT5®

SPORT CONCUSSION ASSESSMENT TOOL – 5TH EDITION

DEVELOPED BY THE CONCUSSION IN SPORT GROUP
FOR USE BY MEDICAL PROFESSIONALS ONLY

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Child SCAT5 – Age 5–12

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 professionals¹.

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.

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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 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.

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Evidence

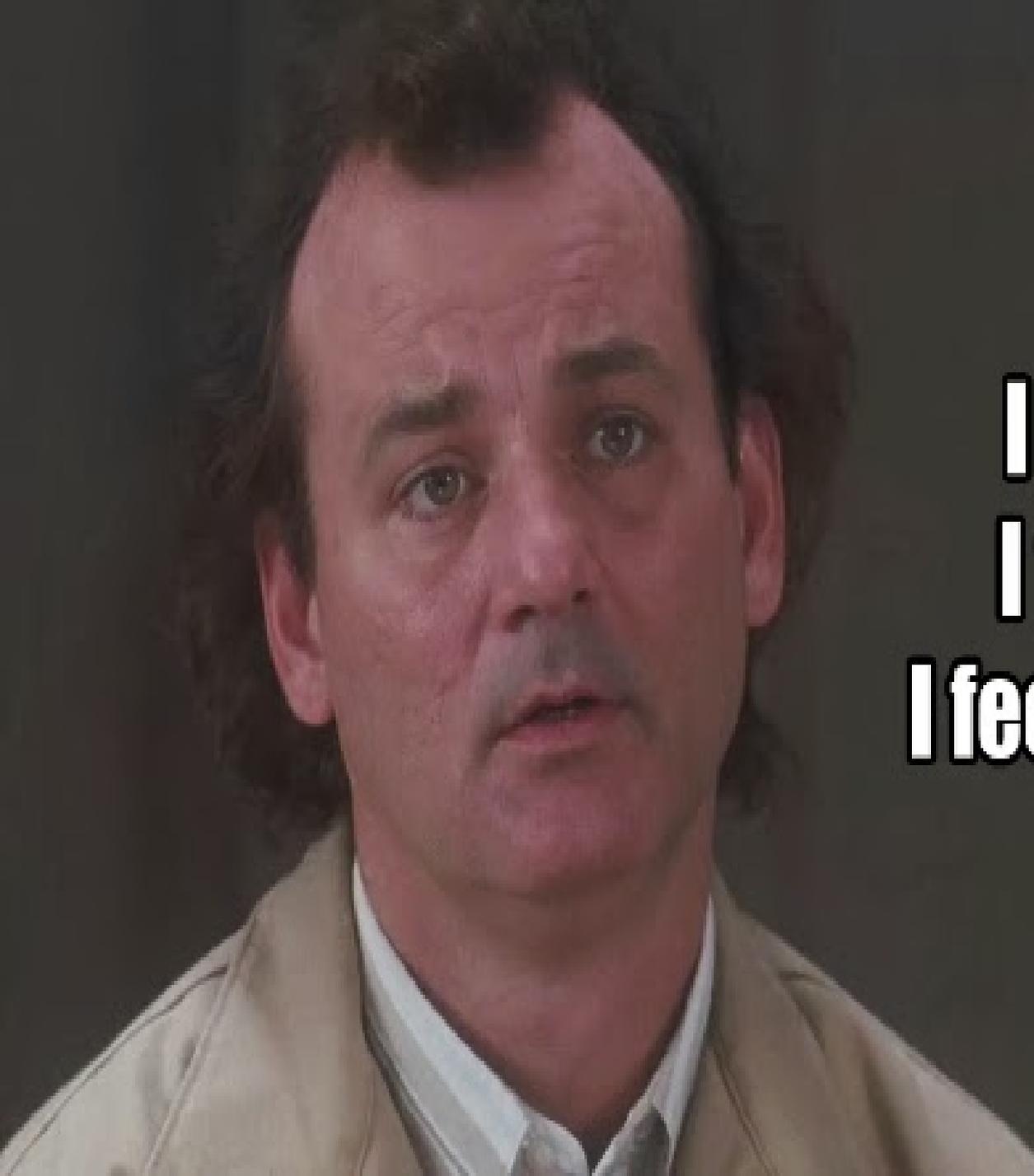
- ▶ Level B evidence= Inconsistent or limited-quality, patient-oriented evidence.
- ▶ Level C evidence= Consensus, disease-oriented evidence, usual practice, expert opinion, or case series for studies of diagnosis, treatment, prevention or screening

Field Assessment Level C

- ▶ Observation during practice and competition by medical personnel is valuable for recognition and initial management.
- ▶ Reasons for immediate removal and prompt evaluation
 - loss of consciousness (LOC), impact seizure, tonic posturing, gross motor instability, confusion or amnesia.
- ▶ Activate emergency action plan
 - Prolonged LOC, severe or worsening headache, repeated emesis, declining mental status, focal neurological deficit or suspicion of significant cervical spine injury.

Field Assessment Level C

- ▶ Immediate removal if video review demonstrates
 - LOC, motor incoordination or balance problems, or having a blank or vacant look.
- ▶ A healthcare professional familiar with the athlete is best suited to detect subtle changes in the athlete's personality or test performance.
- ▶ Concussion assessment
 - Performed in a distraction-free environment with adequate time for examination and administration of concussion tests.
 - If clear SRC, additional sideline testing can be discontinued.
 - Sport-specific rules may not allow adequate time for evaluation.



I feel good
I feel great
I feel wonderful

Field Assessment Level C

- ▶ A brief history from the athlete and those who witnessed the event or athlete behavior.
- ▶ How the athlete responds to the elements of orientation, memory, concentration and balance is evaluated, as well as speech patterns and how the athlete appears to be processing information.
- ▶ Cervical palpation and range of motion (ROM) are also typically performed to assess for other injury.
 - Preliminary evaluations are followed by a thorough and specific concussion assessment.

Field Assessment Level B

- ▶ Knowledge of test reliability can assist in differentiating SRC changes from normal variation.
 - Test-retest reliability of sideline concussion tests are below accepted threshold for clinical utility.
- ▶ Many tests have a learning effect.
- ▶ The sensitivity and specificity of many of the individual tests used to evaluate concussion are not ideal.
 - Area under the curve of a receiver operator characteristic curve is another way to evaluate the usefulness of a test.

Field Assessment Level B

- ▶ Combining tests of different functions to form a multimodal assessment increases sensitivity and specificity for diagnosis.
- ▶ Age needs to be considered when using and evaluating testing tools.
- ▶ SRC is a heterogeneous injury contributing to the varied sensitivity of screening tools, which are often domain-specific assessments.
- ▶ All tests should be interpreted in combination with relevant clinical information to arrive at the most accurate conclusion.

Field Assessment Level B

- ▶ Symptoms are the most sensitive indicator.
- ▶ Athlete–reported symptoms depends on accurate reporting.
 - Lack of recognition of the signs and symptoms
 - Conscious false reporting to avoid loss of playing time.
- ▶ Any increase in symptoms after a suspected concussion should cause athlete to be held from play until further evaluation can confirm or exclude SRC.

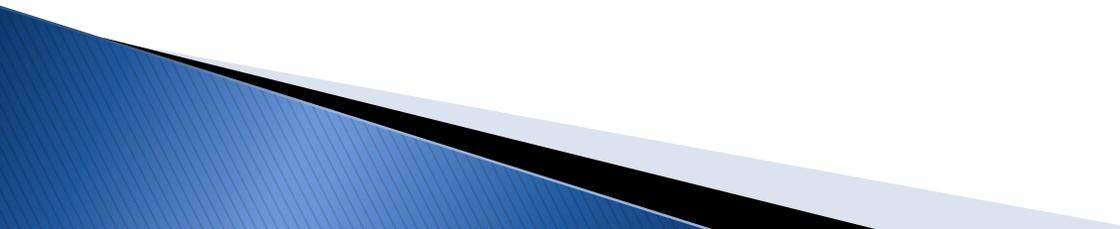


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Field Assessment Level C

- ▶ SCAT5 and the Child SCAT5 are the recommended tools by the Concussion in Sport Group (CISG) for assessing a suspected concussion.
- ▶ The SCAT5
 - Brief neurological examination, symptom checklist, brief cognitive assessment (the Standardized Assessment of Concussion [SAC]) and a balance assessment (the modified-Balance Error Scoring System).
 - SAC in the SCAT5 offers optional 10-word lists for immediate and delayed memory and longer digit backwards sequencing to minimize the ceiling effect, a weakness of the SCAT3.
- ▶ Currently no study of the SCAT5 or Child SCAT5's sensitivity and specificity for SRC determine if these versions are improved over earlier versions.

Field Assessment Level C

- ▶ The primary endpoint for sideline assessment is to determine the probability that an athlete has sustained a concussion.
 - ▶ If the athlete is deemed unlikely to have had a concussion, continued participation should be safe.
 - ▶ If the evaluation indicates a definite or probable concussion, the athlete should be removed from participation with no same-day return to play.
 - ▶ SRC is an evolving injury and should be serially reassessed.
- 

Field Assessment Level C

- ▶ Vestibular–ocular function and reaction time.
 - More frequently used in the office setting
 - Formal VOMS testing on the sideline has not yet been studied

Vestibular ocular-motor screening (VOMS)

- ▶ Smooth Pursuits – Follow a slowly moving target.
- ▶ Saccades – Ability of the eyes to move quickly between targets
 - Horizontal and vertical
- ▶ Convergence – Ability to view a near target without double vision
 - <5cm
- ▶ Vestibular–Ocular Reflex (VOR) Test – Ability to stabilize vision as the head moves
- ▶ Visual Motion Sensitivity (VMS) Test – Motion sensitivity and the ability to inhibit vestibular–induced eye movements using vision

Smooth Pursuits (Horizontal & Vertical)
Tests ability to follow a slowly moving target

Both patient and clinician are seated
Patient follows finger with eyes
Do NOT move head, just eyes
2 reps at rate of 2 sec / rep
Rate symptoms (0-10)
Complete for both horizontal & vertical

Saccades (Horizontal & Vertical)
Tests ability of eyes to move quickly between targets

Both patient and clinician are seated
Clinician holds fingers 3' apart
Patient initially looks L-R
Do NOT move head, just eyes
10 reps as quickly as possible
Rate symptoms (0-10)
Repeat with patient looking Up-Down

Convergence
Measures ability to view a near target without double vision

Patient holds target with 14-point font "X" at arms length
Patient brings target toward eyes focusing on the "X"
Stop when they see double
Clinician measures distance from lip of nose to target (cm)
Repeat 3x, record all 3
Rate symptoms (0-10)

Visual Motion Sensitivity
Tests visual motion sensitivity & ability to inhibit vestibular induced eye movements using vision

Patient holds arm outstretched in front with thumbs up
Turn body as a unit to L-R 80 deg from midline focusing on thumb
Use metronome 50 bpm
Repeat 5 revolutions
Rate symptoms (0-10)

Vestibular-Ocular Reflex (Horizontal & Vertical)
Assess ability to stabilize vision as head moves

Clinician holds target 3' from patient's eye level
Patient initially turns head L-R 10x
Keep eyes focused on target
Use metronome 180 bpm
Wait 10 seconds
Rate symptoms (0-10)
Repeat with patient looking Up-Down

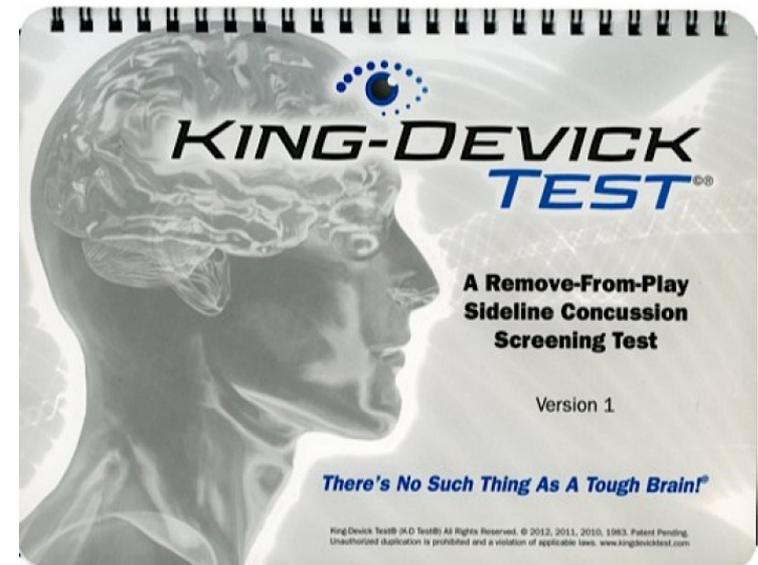
VOMS

Vestibular/Ocular Motor Test:	Not Tested	Headache 0-10	Dizziness 0-10	Nausea 0-10	Fogginess 0-10	Comments
BASELINE SYMPTOMS:	N/A					
Smooth Pursuits						
Saccades – Horizontal						
Saccades – Vertical						
Convergence (Near Point)						(Near Point in cm): Measure 1: _____ Measure 2: _____ Measure 3: _____
VOR – Horizontal						
VOR – Vertical						
Visual Motion Sensitivity Test						

Field Assessment Level C

- ▶ King-Devick (KD) test is a proprietary timed saccadic eye movement test requiring individuals to quickly read numbers aloud.
 - Requires a baseline test
 - Potential learning and practice effects to be useful.
 - Simple reaction time as a sideline screen has also been studied using a dropped weighted stick.

- ▶ Further research including larger numbers and control subjects is needed for these tests.

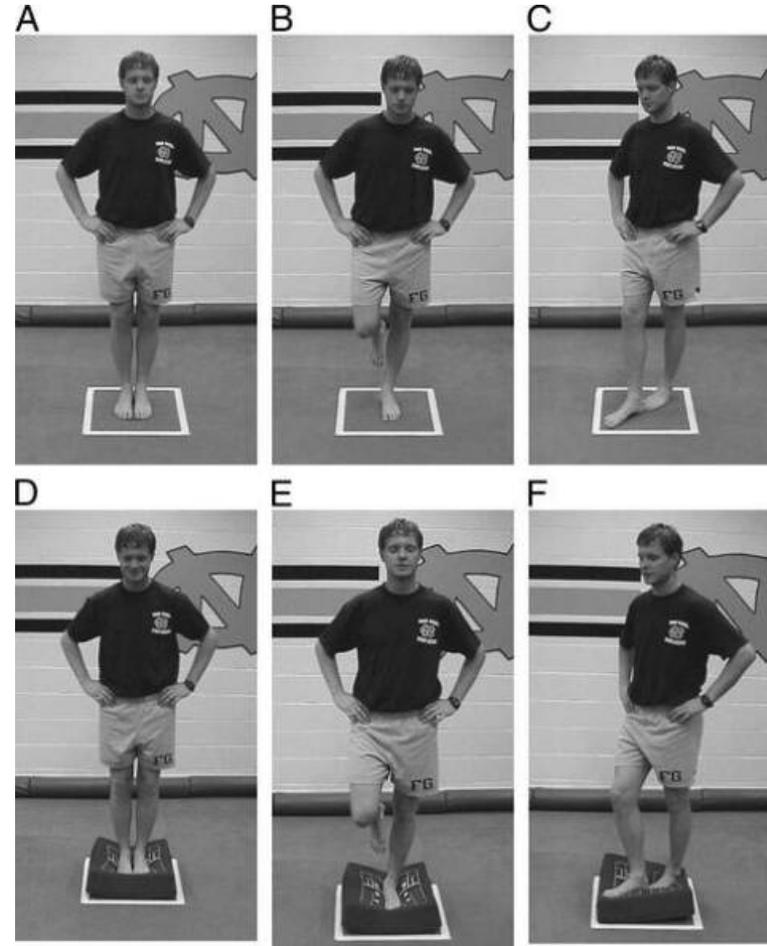


Balance Error Scoring System – BESS Testing

- ▶ Used to assess balance after Concussion
 - Used as a sideline assessment tool (modified)
 - Used as a tool to follow resolution of concussion / post-concussion syndrome
- ▶ Each error results in 1 point (10pts max per trial).
- ▶ All points added together at the end of the 6 test to give a total score
 - Used in comparison with baseline or previous score

BESS Testing

- ▶ Test Begins when athlete closes eyes
 - Make any necessary adjustments with balance loss
 - Return to test-position immediately
- ▶ Test 1 : Double leg stance
- ▶ Test 2 : Single leg stance (nondominant foot)
- ▶ Test 3 : Tandem stance (nondominant rear)
- ▶ 20 seconds per test
 - Each done on both solid and foam surface



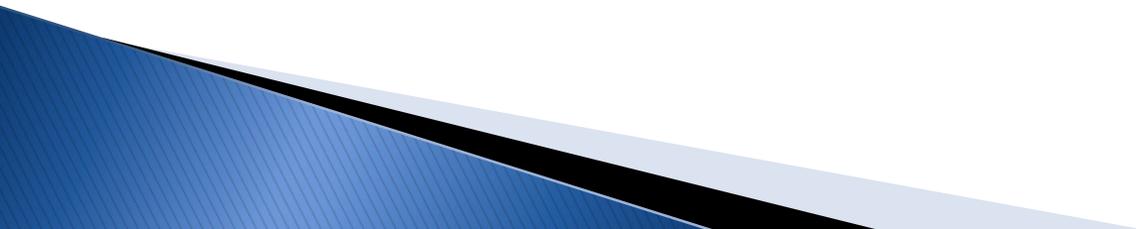
Field Assessment Level C

- ▶ App-based measures
 - Reaction time
 - Eye trackers
 - Postural stability
 - Speech pattern
 - Quantitative electroencephalography
- ▶ Some are available on portable electronic platforms with the ability to share information with multiple users.
- ▶ These newer technologies do not have sufficient research to establish their utility.

Wearable Monitors Level B

- ▶ No validated evidence that they work or provide information that is actionable
- ▶ Potential things that effect
 - Number
 - Location
 - Density
 - Individual threshold

Further Testing



Scanning

- ▶ CT
- ▶ MRI
 - Diffusion tensor(DT)
 - Resting state functional (RSF)
 - Quantitate susceptibility
 - Spectroscopy
 - Arterial spin labelling
 - May use in atypical prolonged recovery
 - Not sure of utility, needs more data (B)

Biomarkers

- ▶ Blood, saliva, CSF
 - Likely more beneficial in pathophysiology and neurobiological recovery
 - FDA approved two-protein brain trauma indicator with glial fibrillar acidic protein and ubiquitin carboxy-terminal hydrolase L1, and clinical use of S100 calcium-binding protein β
 - Benefit is to decrease the use of CT in ruling out intracranial bleed
 - No role in diagnosing or managing SRC (B)
 - Genetic testing
 - No scientific support in evaluation or management of SRC (B)

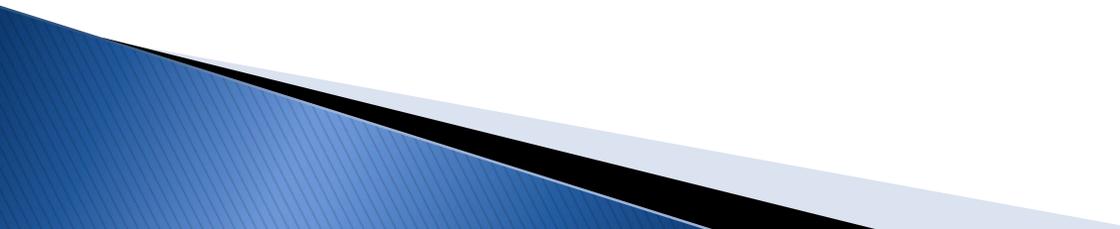
Doc- Wanna hear a concussion joke?

Guy- Sure.

Doc- A guy walks into a bar.



Management

- ▶ Relative rest
 - ▶ No specific medications
 - ▶ Serial monitoring of symptoms
 - ▶ +/- Computerized testing
 - ▶ +/- Neuropsychology or neurology evaluation
 - ▶ +/- Neuroimaging
- 

Recovery

- ▶ Symptoms typically resolve spontaneously
 - 80%–90% of concussed older adolescents and adults returning to preinjury levels of clinical function within 2 weeks.
- ▶ Younger athletes, clinical recovery may take longer
 - Return to preinjury levels of function within 4 weeks.

Recovery

- ▶ Most consistent predictor of recovery is the number and severity of acute and subacute symptoms.
 - Subacute headache and depression after injury are risk factors for symptoms persisting for >1 month.
- ▶ Athletes with learning disabilities or ADD/ADHD do not appear to be at risk for prolonged recovery.
- ▶ More research is needed to determine if age and sex affect recovery
 - Some studies demonstrate a longer period of reported symptoms in women and adolescent.
- ▶ Lower symptom-limited heart rate threshold during graded exercise testing within a week of SRC in adolescents predicts a longer recovery time.

Prescribed Rest

- ▶ Strict rest slowed recovery and led to an increased chance of prolonged symptoms and may have detrimental effects
 - Similar to social isolation effects seen in animal studies and is no longer recommended.
- ▶ Consensus guidelines endorse 24–48 hours of symptom-limited cognitive and physical rest.
- ▶ Gradual increase in activity, staying below symptom-exacerbation thresholds.

Activity and Rest

- ▶ Exercise improves
 - Autonomic nervous system balance and CO₂ sensitivity
 - Cerebral blood flow regulation
 - Brain-derived neurotrophic factor gene upregulation
 - Mood and sleep
- ▶ Early symptom-limited graded exercise testing appears to be safe in athletes.
 - Preliminary evidence that sub-symptom threshold exercise improves recovery
- ▶ Early activity and exercise do not take the place of a graded return to sport.

Medications

- ▶ No medication to directly treat concussion
- ▶ Avoid NSAIDs
 - Tylenol if needed



Nutraceuticals

- ▶ Emerging evidence in animal models that some supplements may protect or speed recovery from concussion.
 - Certain B vitamins, omega-3 fatty acids, vitamin D, progesterone, N-Methyl-D-aspartate, exogenous ketones and dietary manipulations (eg, ketogenic diet).
- ▶ There is no human evidence that nutraceuticals prevent or ameliorate concussion in athletes.

Return to Learn

- ▶ Notify school personnel after injury to prepare for return to school.
 - ▶ Develop plan for missed assignments and exams.
 - ▶ Adjust schedule to accommodate reduced or modified attendance if needed.
- 

Return to Play/Activity



Return to Sport

Stage	Description	Objective
1	Symptom-limited activity	Reintroduction of normal activities of daily living. Symptoms should not worsen with activity.
2	Light aerobic exercise	Walking, stationary biking, controlled activities that increase heart rate.
3	Sport-specific exercise	Running, skating or other sport-specific aerobic exercise avoiding risk of head impact.
4	Non-contact training drills	Sport-specific, non-contact training drills that involve increased coordination and thinking. Progressive introduction of resistance training.
5	Full contact practice	Return to normal training activities. Assess psychological readiness.
6	Return to sport	

Persistent Post Concussive Syndrome (PPCS)



PPCS

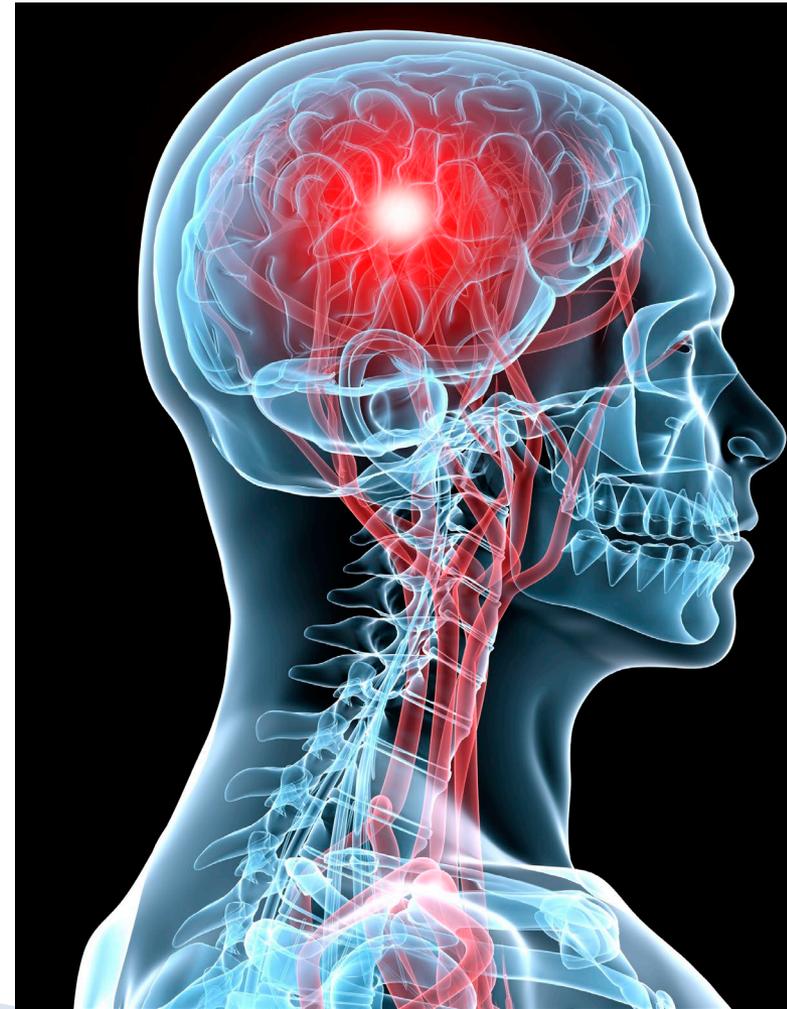
- ▶ Symptoms that persist beyond the expected recovery time frame (>2 weeks in adults, >4 weeks in children).
- ▶ Persistent symptoms do not necessarily represent ongoing concussive injury to the brain.
- ▶ It is not unusual for common symptoms to be inappropriately or mistakenly attributed to concussion; therefore, it is critical to understand pre-existing or coexisting symptoms and conditions in the evaluation of PPCS.

Exercise in PPCS

- ▶ Activity and exercise that do not exacerbate symptoms
 - ▶ A formal symptom-limited aerobic exercise program has been shown to be safe and improve resolution of persistent symptoms compared with controls
 - ▶ The Buffalo Concussion Exercise Treatment Protocol, a progressive sub-symptom threshold aerobic exercise program
 - ▶ Ideal to be evaluated by a provider or team with expertise in complicated concussion management.
- 

Neurology/Neuropsychology Referral

- ▶ Protracted recovery
- ▶ Focal neurological deficit
- ▶ Multiple concussions
- ▶ Further clarify cognitive deficits
- ▶ Academic accommodations
- ▶ More detailed testing
- ▶ May include counseling



Neuropsych Tests

- ▶ ImPACT
 - Most common
 - Baseline testing important
 - Repeat testing after concussion
 - Shortly after injury or at symptom resolution
- ▶ Computerized Cognitive assessment Tool (CCAT)
- ▶ Concussion Resolution Index (CRI)
- ▶ XLNTbrain Sport
- ▶ Concussion Vital Signs
- ▶ Automated Neuropsychological Assessment Metrics (ANAM) system
- ▶ Paper/pencil testing

Multiple Concussions

- ▶ Repeated injuries can cause long-term functional impairment and neuropsychological deficits
- ▶ Often times the number and severity of concussions are not known
- ▶ Clearance
 - Must individualize the situation
 - Rely on neuropsychologic input
 - No scientific studies have developed firm guidelines as of yet

Disqualification from Sport

- ▶ There are no evidence-based guidelines for disqualifying or retiring an athlete from sport after concussion
- ▶ There is no 'set' number of concussions or repetitive head impact exposures that should force retirement from a season or from sport
- ▶ Contraindications for continued participation may include behavioral changes, post-traumatic seizures, persistent neurological deficit or imaging findings suggesting additional/other pathology

Prevention

- ▶ Prevention is ultimately more effective in reducing the burden than any treatment
 - Rule changes
 - Enforcement of existing rules
 - Technique changes
 - Neck strengthening
 - Equipment modifications
- ▶ There is moderate evidence that delaying body checking in youth hockey reduces concussion rates
- ▶ The effectiveness of rule changes in youth soccer and football is not clear
- ▶ Initial evidence reveals practice modification and changes in tackling technique may reduce injury.

Prevention

- ▶ There is conflicting evidence regarding mouthguards
- ▶ Helmets prevent skull trauma and intracranial bleeding, but their protective effects for concussion are less pronounced
- ▶ Some football helmet designs have improved the ability to absorb force, but it is unknown if this will reduce concussion incidence
 - Player behavior can change when wearing new or 'improved' protective equipment
 - Encourage a more aggressive style of play, potentially increasing the risk for injury.

Summary

- ▶ Concussions occur with significant frequency through a variety of sports.
 - ▶ Presentation of injury is wide ranging
 - ▶ Young athletes/students should be treated more conservatively than adult counterparts
 - ▶ Graduated return to play with health care team supervision provides the most successful and safest return to sports
 - ▶ Set realistic goals, keeping in mind appropriate age related recovery times
 - ▶ ADD/ADHD unrelated while low HR threshold within 1wk is related
 - ▶ Early graded increase in activity in asymptomatic athletes with PPCS
- 

Thank You



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Resources

- ▶ CDC – Heads Up (www.cdc.gov/concussion)
 - Resources for coaches, parents, health care providers, schools
- ▶ AMSSM Consensus Statement
 - <https://bjsm.bmj.com/content/53/4/213>

Medical Professionals

- ▶ Monmouth/Ocean county NJ
 - William Gallagher, MD
 - Thomas Sargent, DO
 - Kristine Keane, PSY.D

Questions

