Concussion Diagnosis and Management

Stephen F Cromer Jr, DO, MS
Assistant Professor, Virginia Tech Carilion
Institute for Orthopaedics and Neurosciences

CARILION CLINIC

Team Physician Consensus Conference (TPCC)

Consensus statement

Selected issues in sport-related concussion (SRC|mild traumatic brain injury) for the team physician: a consensus statement

Stanley Herring,[1] W Ben Kibler,[2] Margot Putukian ,[3] Gary S Solomon,[4] Lori Boyajian-O'Neill,[5] Katherine L Dec,[6] R Robert Franks,[7] Peter A Indelicato,[8] Cynthia R LaBella ,[9,10] John J Leddy ,[11] Jason Matuszak,[12] E Barry McDonough,[13] Francis O'Connor,[14] Karen Michelle Sutton[15]

ABSTRACT

Selected Issues in Sport-Related Concussion (SRC|Mild Traumatic Brain Injury) for the Team Physician: A Consensus Statement is title 22 in a series of annual consensus documents written for the practicing team physician. This document provides an overview of selected medical issues important to team physicians who are responsible for athletes with sports-related concussion (SRC). This statement was developed by the Team Physician Consensus Conference (TPCC), an annual project-based alliance of six major professional associations. The goal of this TPCC statement is to assist the team physician in providing optimal medical care for the athlete with SRC.

the topic area. The executive committee assigns select topics from the outline for the representatives who perform an evidence-based review of the existing literature. The outline is reviewed and modified by the executive committee and expert panel members and they then formulate statements that are supported by the literature and best practices into a format of 'essential' and 'desirable' information that the team physician is responsible for understanding. 'Essential' statements are information that every and any team physician[3] must be responsible for understanding, whereas 'desirable' statements are those that are ideal, in the setting where every resource is available. TPCC papers are intended to provide general recommendations but are

Br J Sports Med: first published as 10.1136/bjsports-2021-104235 on 16 June 2021.

Definition – Sports Related Concussion

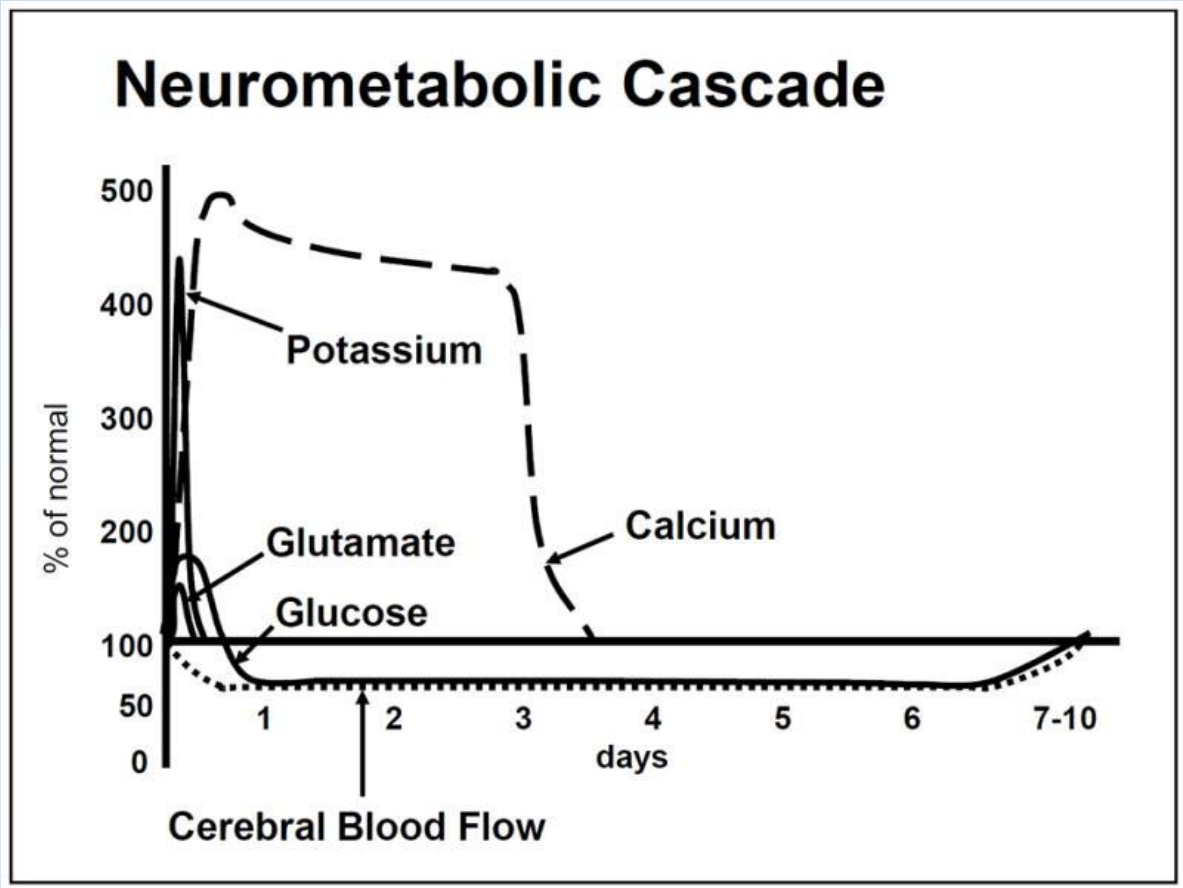
- Short version: A traumatically induced transient disturbance of brain function that involves a complex pathophysiologic process.
- It is a subset of mild traumatic brain injury (mTBI).

Key Points from TPCC

Key points

- The diagnosis of sport-related concussion (SRC) remains a challenge due to non-specific symptoms and lack of objective biomarkers.
- SRC is a treatable condition.
- The number and severity of initial symptom burden is the best predictor for the duration of recovery.
- Current evidence suggests strict rest after SRC slows recovery and increases the probability of prolonged symptoms.
- The majority of athletes with SRC recover within a typical timeframe (2 weeks for adults and up to 4 weeks for children).
- Persisting Symptoms after SRC (PSaSRC) is defined as symptoms that last longer than the typical timeframe. The pathophysiology underlying PSaSRC is not entirely understood. It is thought PSaSRC is not caused by a single pathologic process, but rather an interaction of postinjury symptoms that are complicated by pre-existing, coexisting and/or resulting biopsychosocial factors.
- The management of disabling PSaSRC often requires a multidisciplinary approach.

Pathophysiology



Pathophysiology

- Stress to neurons.
- Changes in intracellular ion concentrations.
- Indiscriminate release of neurotransmitters.
- Mitochondrial dysfunction.
- Reactive oxygen species.
- Increased glucose utilization/cerebral bloodflow mismatch.
  - Mismatch phase leaves a vulnerable reinjury window

Pathophysiology

Based on animal models

Interpret with caution.

Epidemiology

- SRC rates are higher
  - during competition than practice.
  - for females when playing sports with the same rules for both males and females.
  - for athletes with a history of prior SRC, Attention Deficit Hyperactivity Disorder (ADHD) and/or learning disabilities.
- Sports with highest incidence rates
  - Rugby Union, American football, ice hockey, soccer, wrestling, and lacrosse
  - Based on athlete exposure risk

Epidemiology

Risk:

$$\frac{\text{Number of Concussions}}{\text{Amount of Time in Activities}}$$

Currently most estimates are using "athlete exposures" as the denominator.

Preseason

- Should we be baseline testing?

"Baseline testing may be useful in some cases but is not necessary, required or an accepted standard of care for the appropriate management of SRC."

Sideline Assessment

"SRC is considered to be among the most complex injuries in sports medicine to diagnose, assess and manage."

Sideline Assessment

The diagnosis of SRC is difficult due to "lack of validated, objective diagnostic tests, a reliance on self reported symptoms, and confounding symptoms caused by other common conditions" and because of this it "remains a clinical diagnosis made by carefully synthesizing history and physical exam findings as the injury evolves."

Sideline Assessment

- Sideline and field testing is screening.
- Symptoms have the highest sensitivity
  - # of symptoms has highest prognostic significance
- "The primary endpoint for sideline assessment is to determine the probability that an athlete has sustained a concussion."

Systematic Evaluation

1. Assess level of consciousness (AVPU=Alert, Verbal, Pain, Unresponsive)
2. Assess airway, breathing, and circulation
3. Focused exam to include mental status, focal neurological deficits, and cervical spine status
4. Determine disposition (emergency hospital transport or in-depth sideline assessment)

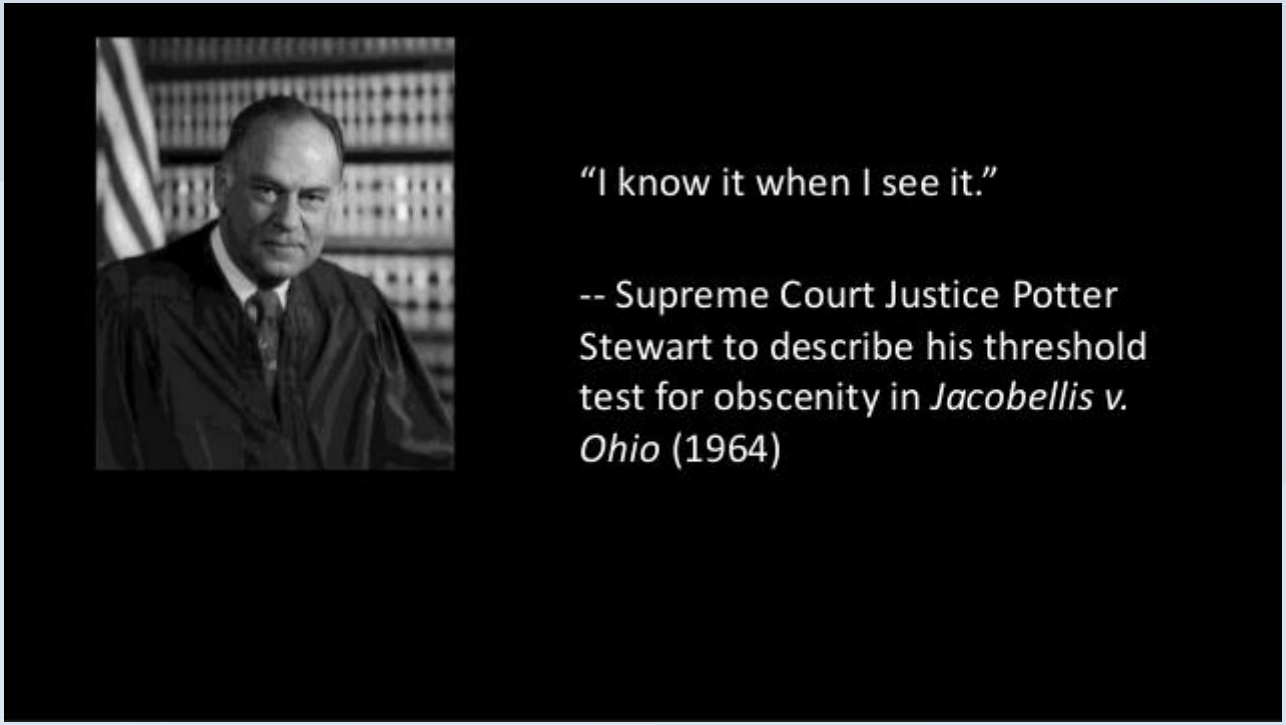
Sideline Assessment

- Immediate Removal:
  - LOC
  - Impact Seizure
  - Tonic Posturing
  - Gross Motor Instability
  - Confusion
  - Amnesia

Sideline Assessment

- Immediate Emergency Hospital Transport:
  - Seizure (at or minutes after impact)
  - More than brief LOC
  - Severe/worsening headache
  - Persistent/recurring emesis
  - Deteriorating neurological status
    - (i.e. increasing lethargy, confusion)
  - Persistent focal neurologic deficit
    - (i.e. tingling or paresthesias in extremities, diplopia)
  - Cervical spine pain, bony tenderness, limited range of motion and/or deformity

“I know it when I see it.”



SCAT 5 – Ages 13 and Up

- Outlines on-field and sideline assessment
- Requires distraction free environment
- Highlights importance of reevaluation
- For use by licensed healthcare professionals only

SCAT5®

SPORT CONCUSSION ASSESSMENT TOOL – 5TH EDITION

DEVELOPED BY THE CONCUSSION IN SPORT GROUP

FOR USE BY MEDICAL PROFESSIONALS ONLY

supported by

FIFA

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.

SCAT5 © Concussion in Sport Group 2017 1

Child SCAT 5 – Ages 5-12

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.

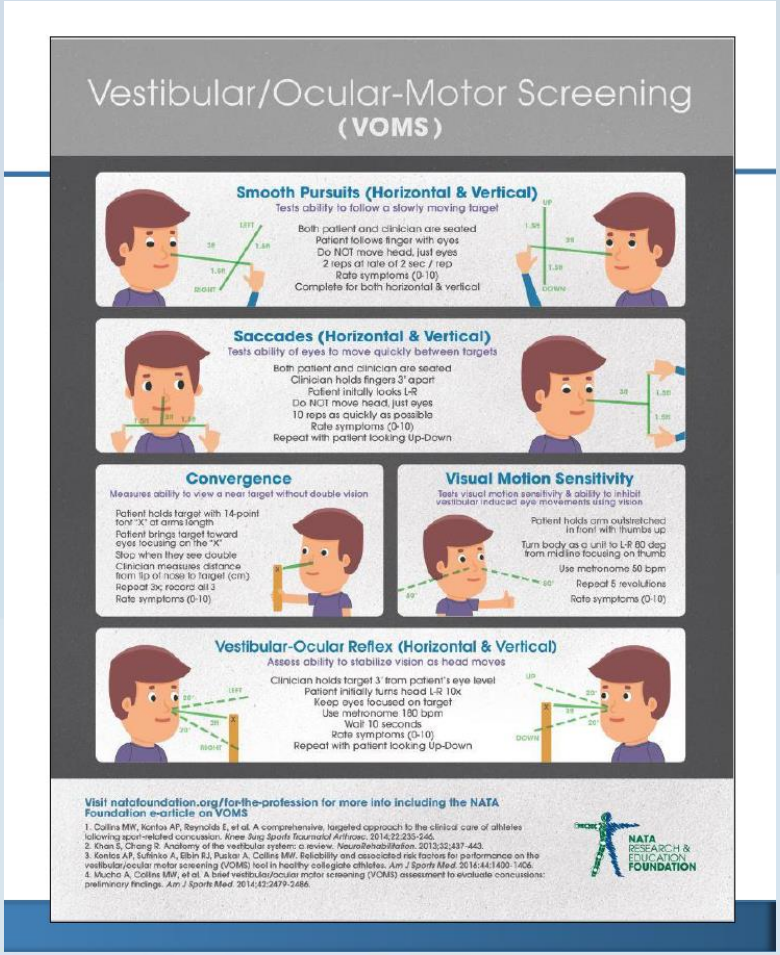
Davis GA, *et al*. *Br J Sports Med* 2017;**51**:862–869. doi:10.1136/bjsports-2017-097492childscat5

Office

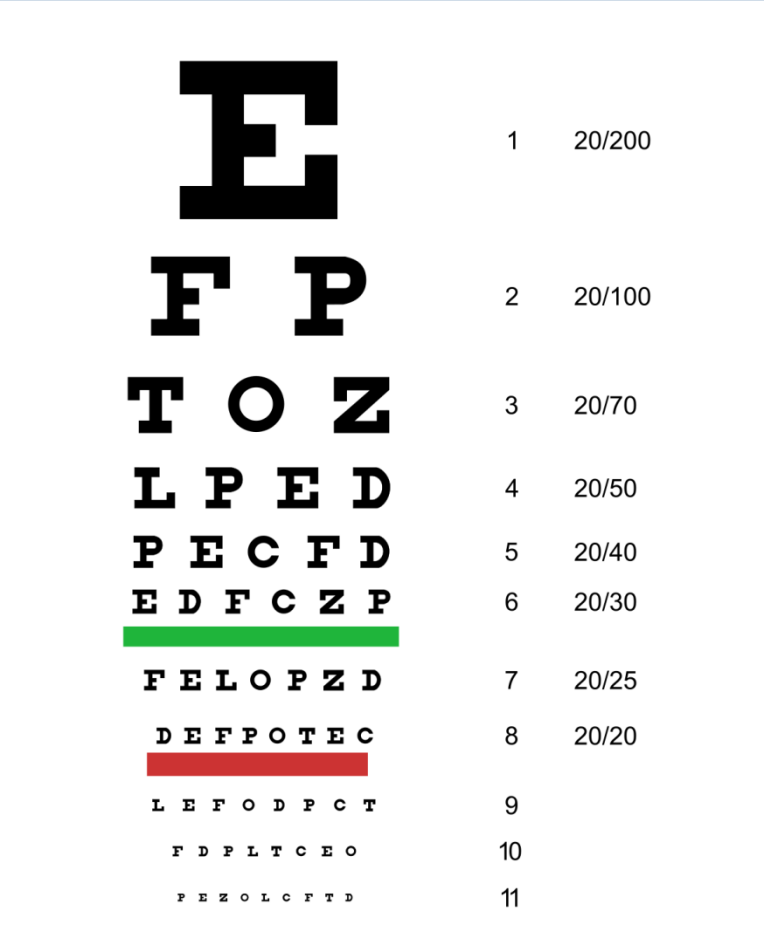
- Comprehensive history
- Neurological exam
- Neurocognitive function
- Sleep history
- Ocular function
- Vestibular function
- Gait
- Balance
- Cervical spine exam

Vestibular/Ocular Motor Screen

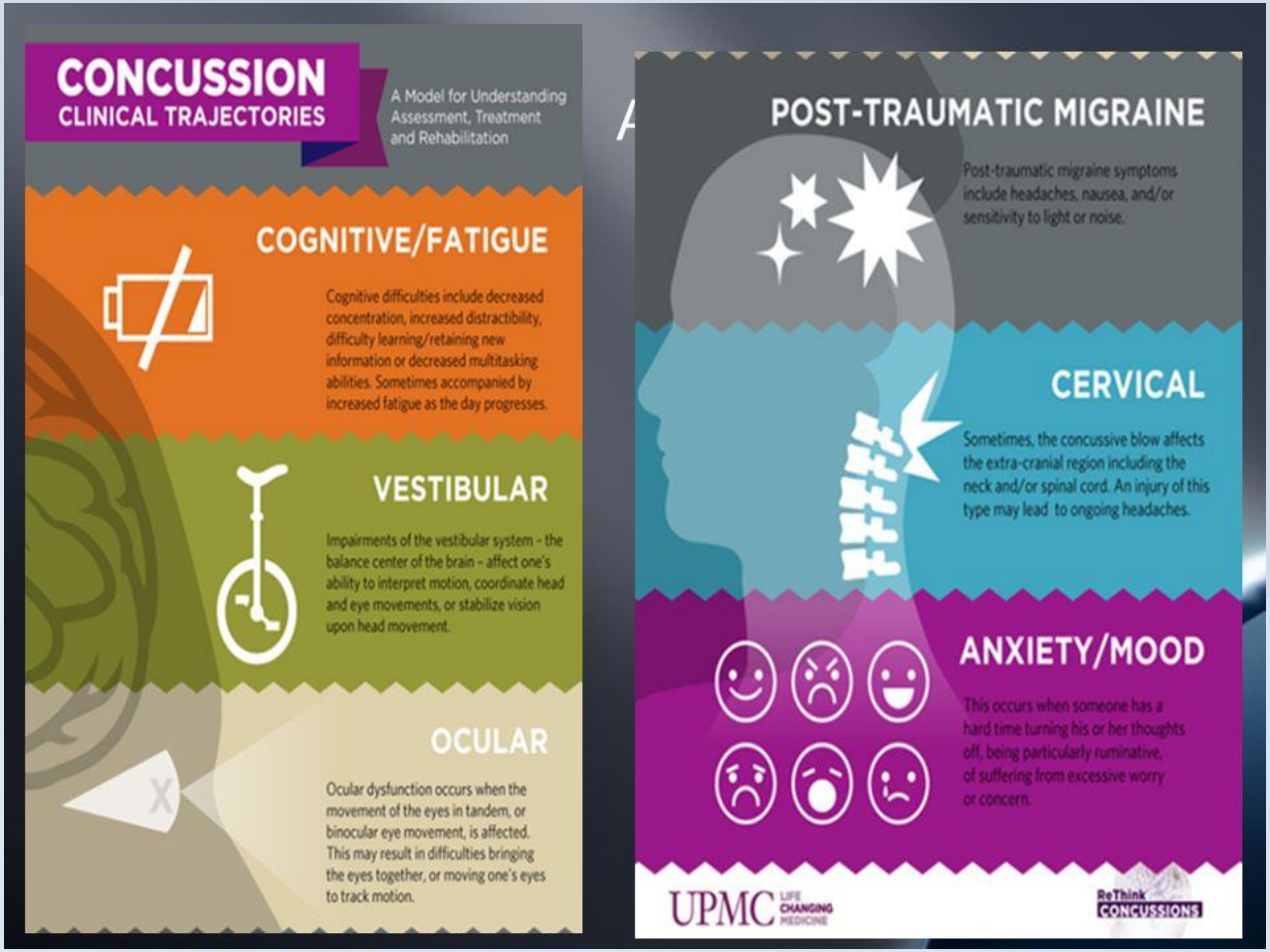
- As many as 69% of concussions have vision symptoms.
- As many as 81% of concussions have vestibular symptoms
- VOMS offers a brief standardized way to assess.



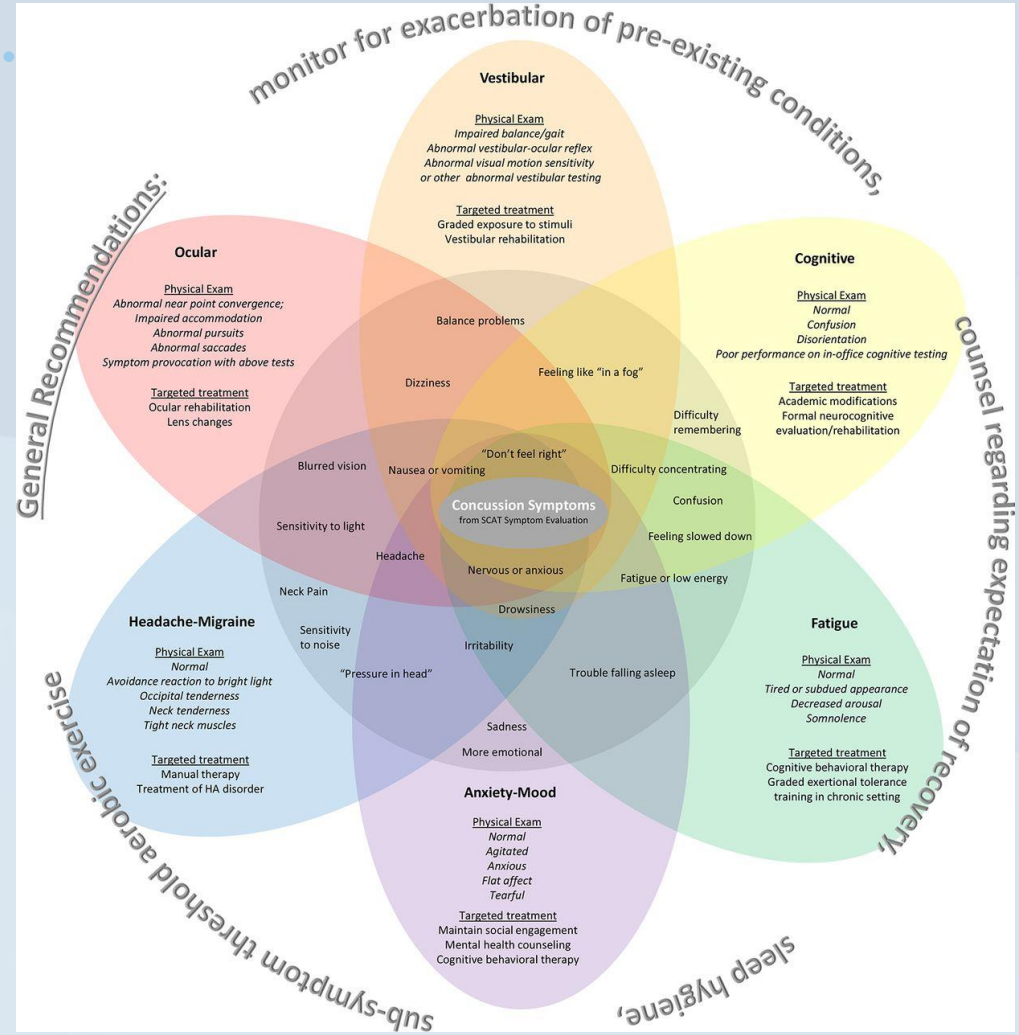
Office


E
1 20/200
F P
2 20/100
T O Z
3 20/70
L P E D
4 20/50
P E C F D
5 20/40
E D F C Z P
6 20/30
F E L O P Z D
7 20/25
D E F P O T E C
8 20/20
L E F O D P C T
9
F D P L T C E O
10
P E Z O L C F T D
11

Clinical Trajectories



Overlapping clinical profiles: an emerging concept to facilitate individualised management after sport-related concussion.



Kimberly G Harmon et al. Br J Sports Med 2019;53:213-225

Predicting Recovery

- 80-90% of older athletes will recover within 2 weeks from SRC
- Younger athletes typically take up to 4 weeks.

Predicting Recovery

- Subacute headache and mood disorders are the best predictors for prolonged recovery (> 4 Weeks).
- The most consistent predictor is number and severity of initial symptoms.

Predicting Recovery

ARTICLE IN PRESS

THE JOURNAL OF PEDIATRICS • www.jpeds.com

ORIGINAL ARTICLES

Concussion Incidence, Duration, and Return to School and Sport in 5- to 14-Year-Old American Football Athletes

Sara P. D. Chrisman, MD, MPH[1,2,3], Sarah Lowry, PhD, MPH[1,4], Stanley A. Herring, MD[3,5], Emily Kroshus, ScD, MPH[1,2], Teah R. Hoopes, MPH[1], Shannon K. Higgins, BS[1], and Frederick P. Rivara, MD, MPH[1,2,3]

Objective To collect prospective data on concussion incidence, risk factors, duration of symptoms, and return to school and sport in 5- to 14-year-old American football participants.

Study design We conducted a prospective cohort study over 2 years collecting data during two 10-week fall seasons. Youth with concussion were followed to determine time to return to school, sport, and baseline level of symptoms. Logistic regression was used to estimate the risk of sustaining a concussion associated with baseline demographic factors. Time to return to school, sport, and baseline symptoms were analyzed using Kaplan-Meier survival curves.

Results Of 863 youth followed (996 player-seasons), 51 sustained a football-related concussion, for an athlete-level incidence of 5.1% per season. Youth with history of concussion had a 2-fold increased risk for sustaining an incident concussion (OR, 2.2; 95% CI, 1.1-4.8). Youth with depression had a 5-fold increased risk of concussion (OR, 5.6; 95% CI, 1.7-18.8). After a concussion, 50% of athletes returned to school by 3 days, 50% returned to sport by 13 days, and 50% returned to a baseline level of symptoms by 3 weeks.

Conclusions Concussion rates in this study were slightly higher than previously reported, with 5 of every 100 youth sustaining a football-related concussion each season. One-half of youth were still symptomatic 3 weeks after

Predicting Recovery

Table II. Odds of confirmed football-related concussion vs no concussion during 1 football season associated with each baseline factor, adjusted for all factors indicated, accounting for clustering by individual (Seattle, 2016-2018)[*,†]

	OR[‡]	(95% CI)	OR[§]	(95% CI)
Child age (y)				
5-7	1.0	Referent	1.0	Referent
8-10	2.91	(0.66-12.95)	2.85	(0.65-12.49)
11-12	2.12	(0.46-9.69)	2.10	(0.47-9.37)
13-14	2.88	(0.57-14.45)	2.78	(0.57-13.48)
Sex				
Male	1.0	Referent	1.0	Referent
Female	1.95	(0.26-14.63)	2.25	(0.30-16.79)
Responding parent education				
High school or less than high school	1.0	Referent	1.0	Referent
Some college, no degree	1.42	(0.36-5.56)	1.34	(0.35-5.12)
College degree	1.22	(0.37-4.06)	1.19	(0.36-3.90)
Masters or professional degree	0.47	(0.10-2.15)	0.47	(0.10-2.17)
Ethnicity				
Not Hispanic or Latino	1.0	Referent	1.0	Referent
Hispanic or Latino	1.80	(0.66-4.90)	1.67	(0.66-4.23)
Race				
White	1.0	Referent	1.0	Referent
Black or African-American	0.25	(0.03-1.96)	0.27	(0.03-2.14)
Asian	0.86	(0.20-3.68)	0.71	(0.18-2.86)
American Indian, Alaskan Native, Native Hawaiian or Other Pacific Islander, or >1 race	0.19	(0.02-1.5)	0.18	(0.02-1.51)
History of prior concussion	**2.24**	**(1.05-4.75)**	1.98	(0.93-4.21)
History of depression	—		**5.59**	**(1.66-18.77)**
History of attention problems	0.99	(0.35-2.77)	0.83	(0.30-2.34)
History of headaches/migraines	1.52	(0.70-3.32)	1.40	(0.61-3.17)
Years playing football (including current year)				
1	1.35	(0.63-2.87)	1.32	(0.62-2.8)
2	1.12	(0.48-2.66)	1.10	(0.46-2.61)
≥3	1.0	Referent	1.0	Referent

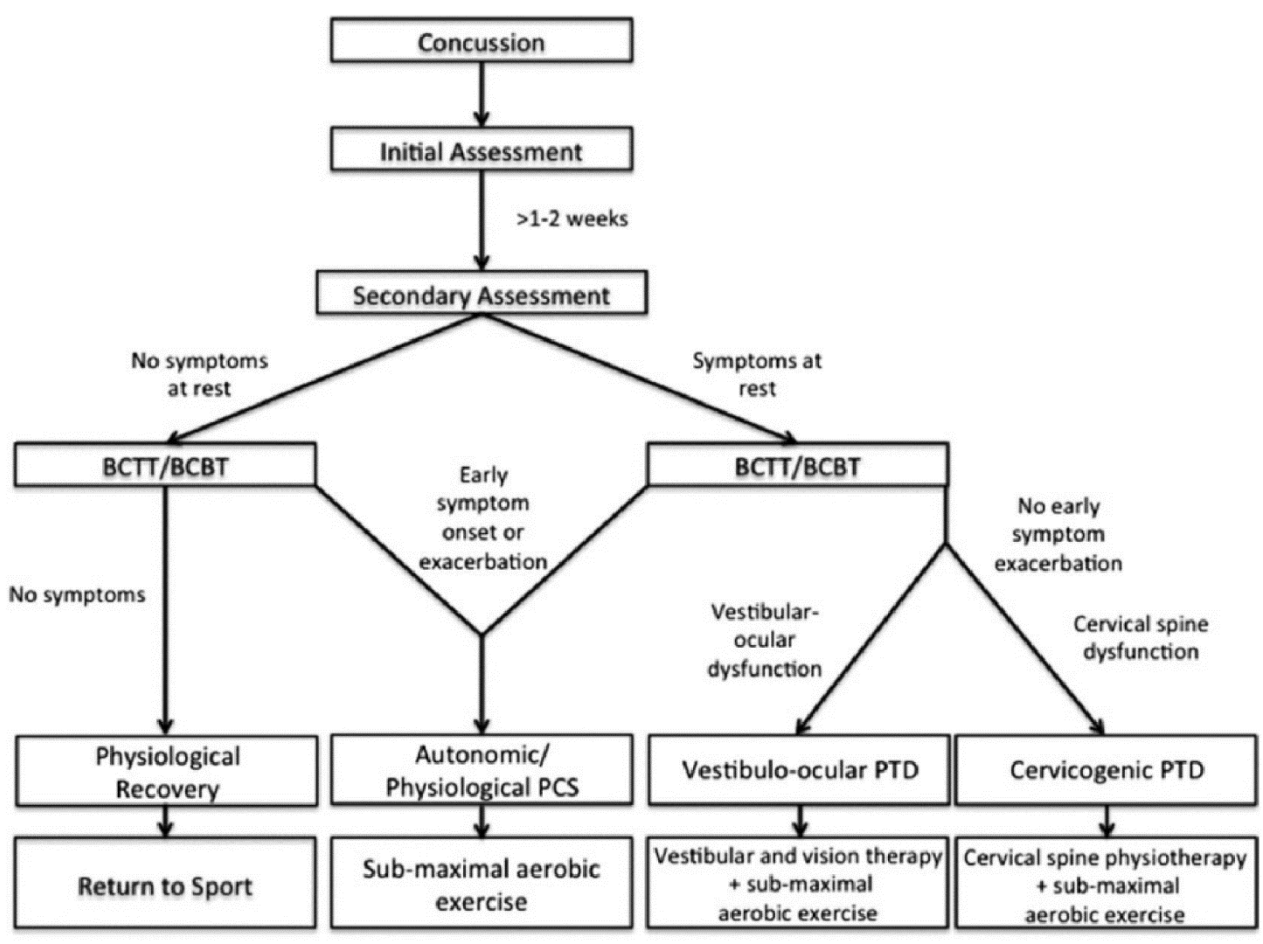
Bold values refer to those Odds Ratios which are significant at $P < .05$.
*Children with suspected but not confirmed concussion were excluded from all analyses.
†The unit of analysis was the player-season; thus, players enrolled both years were included twice. Clustering by individual was accounted for in all analyses.
‡Covariates include all factors shown except for history of depression.

Rest

- “Cocoon Therapy” is out.
- Active recovery is in.

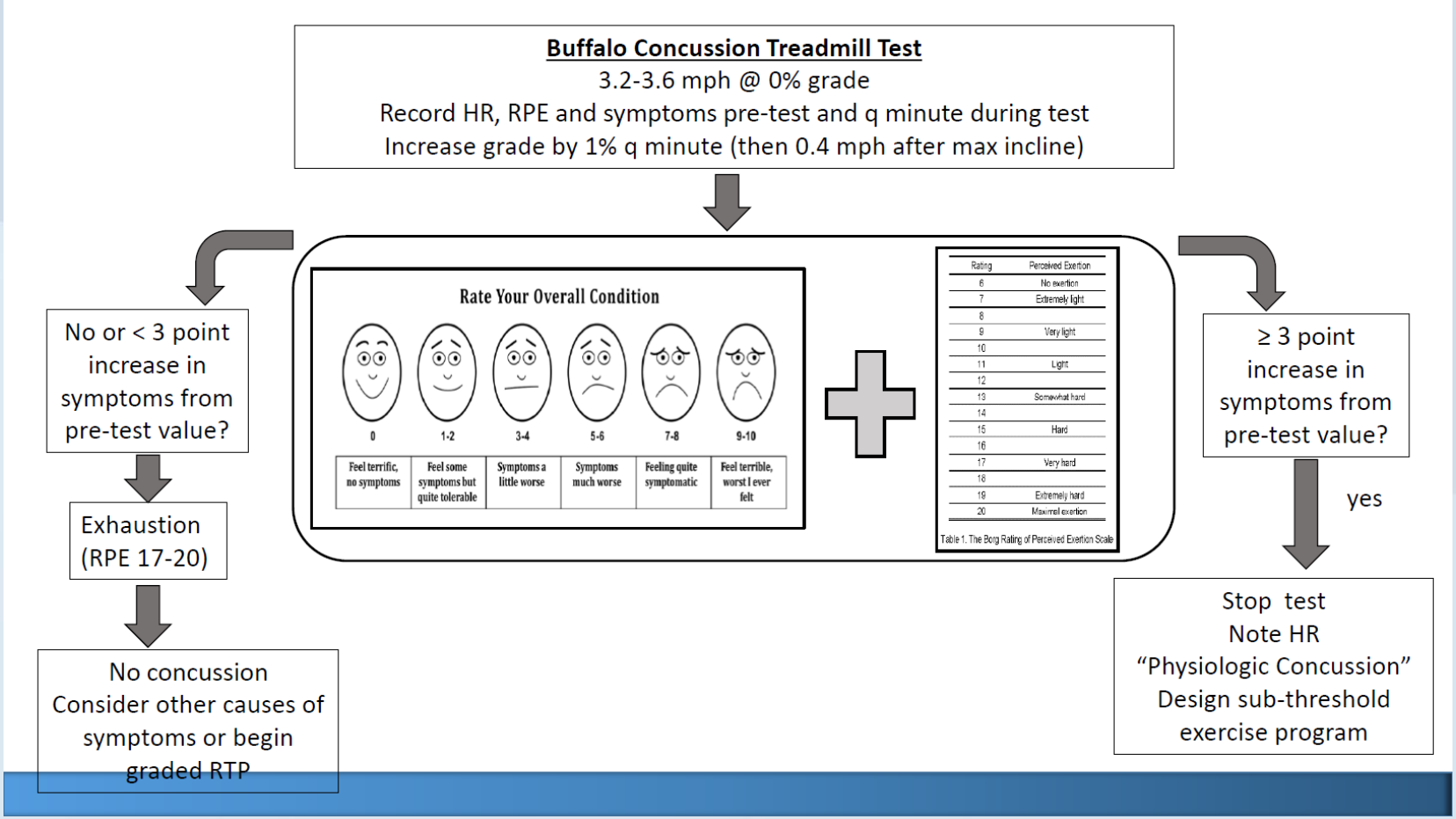
- Strict rest after SRC:
  - slows recovery
  - increases the probability of prolonged symptoms

Active Rest


Concussion
Initial Assessment
>1-2 weeks
Secondary Assessment
No symptoms at rest
Symptoms at rest
BCTT/BCBT
BCTT/BCBT
Early symptom onset or exacerbation
No symptoms
No early symptom exacerbation
Vestibular-ocular dysfunction
Cervical spine dysfunction
Physiological Recovery
Autonomic/ Physiological PCS
Vestibulo-ocular PTD
Cervicogenic PTD
Return to Sport
Sub-maximal aerobic exercise
Vestibular and vision therapy + sub-maximal aerobic exercise
Cervical spine physiotherapy + sub-maximal aerobic exercise

Active Rest

BCTT: 73% sensitivity and 78% specificity for predicting delayed recovery



Return to Sport

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).

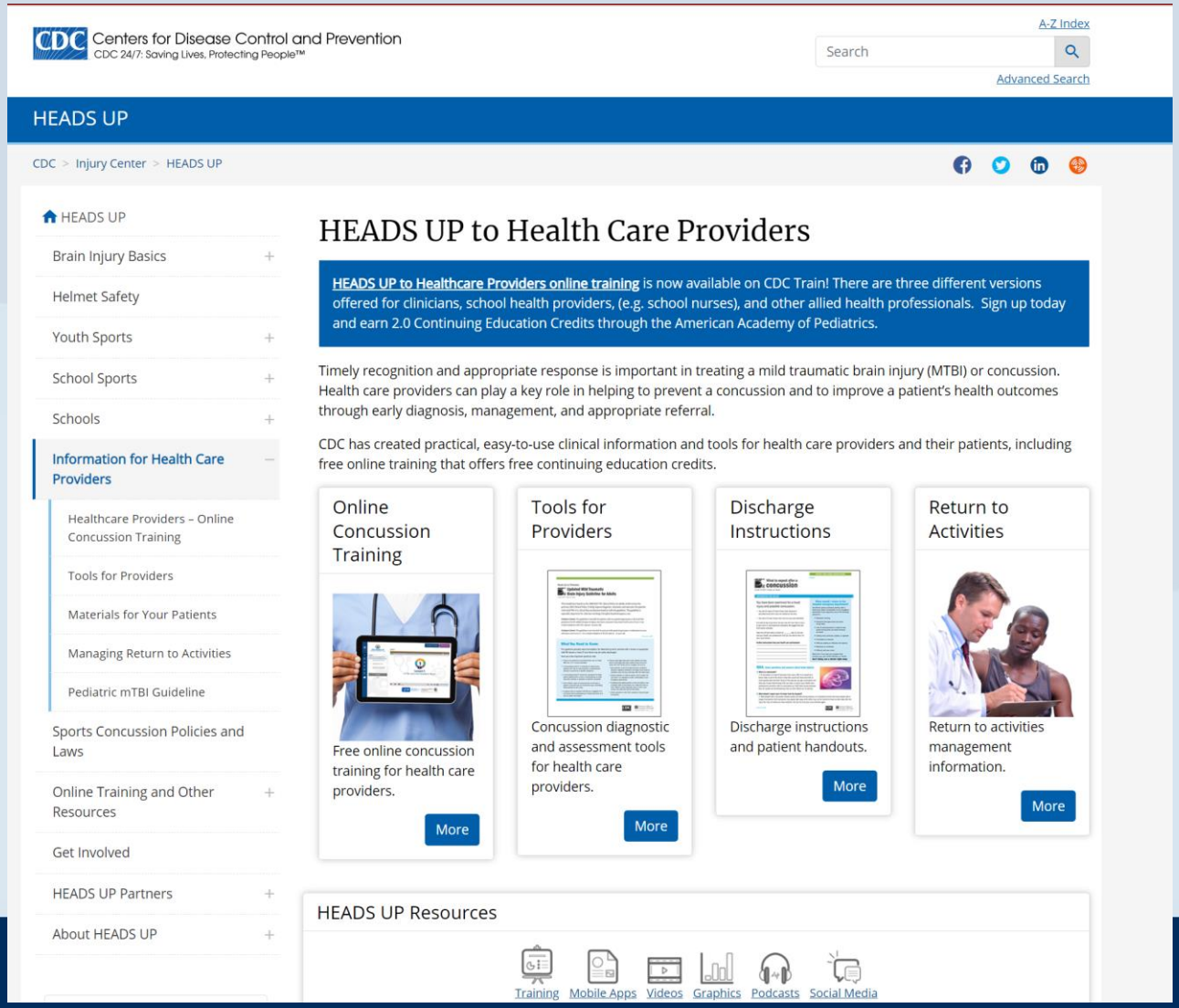
Return to Learn

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

Return to Learn



Return to Learn

POST-CONCUSSION RETURN TO SCHOOL LETTER

Dear School Staff:

[Student]_____ sustained a concussion on ___[Date]_____.

Recovery typically takes between several days to several weeks. The student should return to school as soon as they can tolerate it but many students will benefit from some accommodations to their school programme as they recover. As symptoms resolve and the student's learning/cognitive functioning returns to normal, s/he can gradually progress to their normal school day with reduced supports.

Current Symptoms: The student is currently reporting the following symptoms as indicated by the (√) below. These can be viewed as targets for supportive classroom accommodations to assist a successful return. See suggested supports for these symptoms on page 2.

PHYSICAL		COGNITIVE	EMOTIONAL
□ Headaches	□ Fatigue	□ Feeling mentally foggy	□ Irritability
□ Sensitivity to light	□ Sensitivity to noise	□ Memory problems	□ Anxiety/ nervousness
□ Blurry/double vision	□ Nausea/ vomiting	□ Slowed thinking/ performance	□ Sadness
□ Balance Problems	□ Dizziness	□ Difficulty concentrating	□ Feeling more emotional

Return to School: The student can return to school when:

(1) S/he can concentrate on school work for 30 minutes before symptoms worsen significantly.
(2) Symptom exacerbation reduces/resolves with cognitive rest breaks, allowing return to activity.

Based on the current symptoms, he/she is ___ *permitted to return to school.*
___ *is excused for* _____ *days*

Safety Restrictions: To reduce risk for re-injury, there should be

* No physical (risk) activity during recess
* No sports participation
*No Physical Education (Gym) class
*Other:_____

Physical Activity: Mild-moderate symptom-limited exercise (walking) daily is permitted.

Health Care Provider Signature _____ Date_____

Contact Information_____

Return to Learn

Provision of School Supports: Listed are some suggested accommodations for consideration by school personnel, tailored to the student's specific symptoms:

Post-concussion symptom	Effect on school learning	Accommodation
Physical Symptoms		
Headache	Difficulty concentrating	Frequent breaks, quiet area, hydration
Fatigue	Decreased attention, concentration, low energy	Frequent breaks, shortened day, attendance in fewer classes
Light/noise sensitivity	Worsening symptoms (headache)	Sunglasses, ear plugs/headphones, avoid noisy areas (cafeterias, assemblies, sport events, music class), limit computer work
Dizziness/ balance	Unsteadiness when walking, room feels like it is spinning	Elevator/lift pass (if available) Class transition before bell
Cognitive Symptoms		
Difficulty concentrating	Limited focus on schoolwork	Shorter assignments, decreased workload, frequent breaks, having someone read out loud, more time to complete assignments/tests, quiet area to complete work
Working/ short-term memory	Forgetting instructions, oral lecture, reading material, thoughts during tasks	Repetition; Written instructions Provide student with teacher generated class notes
Difficulty remembering	Difficulty retaining new information, remembering instructions, accessing learned information	Written instructions, smaller amounts to learn, repetition
Slow speed of performance / process	Unable to keep pace with work load, slower reading/ writing/calculation Difficulty processing verbal information effectively	Extended time to complete coursework, assignments, tests Reduce/slow down verbal information and check for comprehension
Emotional Symptoms		
Anxiety	Decreased attention or concentration, overexertion to avoid falling behind	Reassurance and support from teachers about accommodations, reduced workload
Irritability	Poor tolerance for stress (social, academic load)	Reduce stimulation and stressors (e.g., overwhelmed with missing work)

Note: Further information on the Symptom-Targeted Academic Management Plan (STAMP) can be found in (Gioia, in press)[46]

Return to Driving

- No widely accepted protocol
- Driving requires:
  - Coordination of cognitive, visual and motor skills
  - Concentration
  - Attention
  - Visual perception
  - Insight
  - Memory
- Final decision on driving status should be determined during the monitoring period.

Post-concussion Syndrome

- Population that has prolonged symptoms
- Defined by DSM as having:
  - cognitive deficits in attention or memory
  - at least 3 or more of the following symptoms:
    - fatigue, sleep disturbance, headache, dizziness, irritability, affective disturbance, apathy, or personality change.

Virginia Law

VIRGINIA ACTS OF ASSEMBLY -- 2019 SESSION

CHAPTER 142

An Act to amend and reenact § 22.1-271.5 of the Code of Virginia, relating to concussions in student-athletes; guidelines, policies, and procedures.

[H 1930]

Approved February 22, 2019

Be it enacted by the General Assembly of Virginia:

1. That § 22.1-271.5 of the Code of Virginia is amended and reenacted as follows:

§ 22.1-271.5. Guidelines and policies and procedures on concussions in student-athletes.

A. The Board of Education shall develop, *biennially update,* and distribute to each local school division guidelines on policies to inform and educate coaches, student-athletes, and ~~their~~ *student-athletes'* parents or guardians of the nature and risk of concussions, criteria for removal from and return to play, risks of not reporting the injury and continuing to play, and the effects of concussions on student-athletes' academic performance.

B. Each local school division shall develop *and biennially update* policies and procedures regarding the identification and handling of suspected concussions in student-athletes. Such policies shall:

1. Require that in order to participate in any extracurricular physical activity, each student-athlete and the student-athlete's parent or guardian shall review, on an annual basis, information on concussions provided by the local school division. After having reviewed materials describing the short- and long-term health effects of concussions, each student-athlete and the student-athlete's parent or guardian shall sign a statement acknowledging receipt of such information, in a manner approved by the Board of Education;

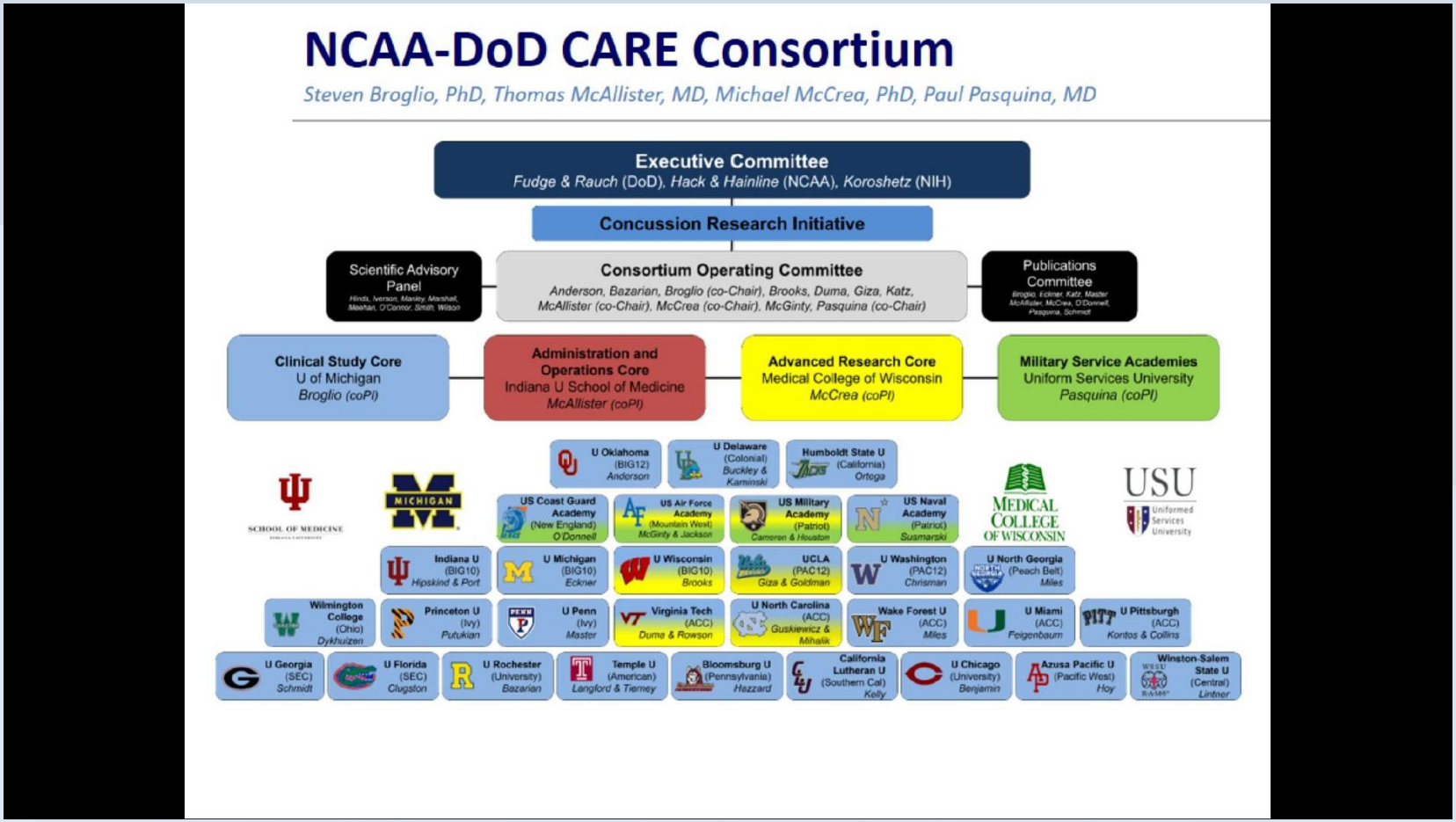
2. Require a student-athlete suspected by that student-athlete's coach, athletic trainer, or team

Zackery Lystedt Law

Future Research

- Nutraceuticals
- Blood tests
- Helmet design
- Neuroimaging
- Depression/mental health
- Chronic traumatic encephalopathy (CTE)

Future Research



NCAA-DOD CARE CONSORTIUM

STUDY MILESTONES

Tracking the CARE study's evolution as it reaches vital funding and research benchmarks. Check back for more updates as the study progresses.

May 2014

$30 million NCAA-Department of Defense Grand Alliance announced.

August 2014

Data collection begins.

September 2015

DOD contributes $11 million in supplementary funding to support the aims of CARE by studying service academy cadets in addition to NCAA student-athletes.

March 2016

CARE Consortium research data is presented at the World Congress on Brain Injury at The Hague, Netherlands.

March 2017

First CARE research paper published.

August 2017

NCAA contributes nearly $1 million for additional member schools to contribute data to the CARE study through CARE Affiliated Programs.

February 2018

NCAA and DOD solidify plans for transition from CARE's first phase (acute effects of concussion and repetitive head impact exposure) to its next (intermediate and cumulative effects of concussion and repetitive head impact exposure).

September 2018

NCAA and DOD contribute an additional $22.5 million in funding for CARE's second phase, CARE 2.0.

October 2021

NCAA-DoD CARE Consortium receives a $42.65 million award to launch CARE-SALTOS Integrated, the third phase of study.

References

- Aubry, M, MD. Summary and agreement statement of the first International Conference on Concussion in Sport. Vienna, 2001.
- Choby, Beth, MD. Sports Related Concussion. FP Essentials. Sept. 2009
- Chrisman, S, MD. Concussion Incidence, Duration, and Return to School and Sport in 5- to 14-Year Old American Football Athletes. The Journal of Pediatrics.2018. 11.003
- Elbin, RJ, PhD. Removal from Play After Concussion and Recovery Time. Pediatrics. 2018.
- Giza, Christopher C. Pathophysiology of Sports Related Concussion: An Update on Basic Science and Translational Research. Sports Health. 2011.
- Harmon, K, MD. American Medical Society for Sports Medicine Position Statement on Concussion in Sport. Br. J Sports Med 2019;53;213-225.
- Leddy, J, MD. Exercise is Medicine for Concussion. Current Sports Medicine Reports. Vol. 17. No. 8. 2018.
- List, Mark. Sports Concussion Management: A Review of the Evidence. Primers in Medicine. September 2014.
- McCrory, P, MD. Summary and agreement statement of the 2nd International Conference on Concussion in Sport. Prague 2004.
- McCrory, P, MD. Consensus Statement on Concussion in Sport – The 3rd International Conference on Concussion in Sport. Zurich, 2008.
- McCrory, P, MD. Consensus Statement on Concussion in Sport – The 4th International Conference on Concussion in Sport. Zurich, 2012.
- McCrory, P, MD. Consensus Statement on Concussion in Sport– The 5th International Conference on Concussion in Sport. Berlin 2016.
- Meier, Timothy B. Recovery of Cerebral Blood Flow Following Sports-Related Concussion. JAMA Neurology. March 2015.
- Mucha, Anne. A Brief Vestibular/Ocular Motor Screening (VOMS) Assessment to Evaluate Concussions: Preliminary Findings. American Journal of Sports Medicine. October 2014.
- Purcell, L. What factors must be considered in 'return to school' following a concussion and what strategies or accommodations should be followed? Br J Sports Med 2019;53:250
- Reneker, Jennifer C. Dizziness after sports-related concussion: Can physiotherapists offer better treatment than just 'physical and cognitive rest?' British Journal of Sports Medicine. 2015.
- Thomas, Donald J. BS. Length of Recovery From Sports-Related Concussions in Pediatric Patients Treated at Concussion Clinics. Clinical Journal of Sports Medicine. 2018.
- Veliz, P. PhD. Prevelance of Concussion Among US Adolescents and Correlated Factors. Journal of the American Medical Association. 2017.
- 22.1-271.5. Guidelines and polices and procedures on concussions in student-athletes. Retrieved from: https://law.lis.virginia.gov/vacode/title22.1/chapter14/section22.1-271.5/

Additional References

- Haider, M. N., Leddy, J. J., Wilber, C. G., Viera, K. B., Bezherano, I., Wilkins, K. J., Miecznikowski, J. C., & Willer, B. S. (2019). The predictive capacity of the Buffalo Concussion Treadmill test after sport-related concussion in adolescents. Frontiers in Neurology, 10. https://doi.org/10.3389/fneur.2019.00395
- Harris, S. A., Dempsey, A. R., Mackie, K., King, D., Hecimovich, M., & Murphy, M. C. (2022). Do Sideline Tests of Vestibular and Oculomotor Function Accurately Diagnose Sports-Related Concussion in Adults? A Systematic Review and Meta-analysis. The American journal of sports medicine, 50(9), 2542–2551. https://doi.org/10.1177/03635465211027946
- Herring, S., Kibler, W. B., Putukian, M., Solomon, G. S., Boyajian-O'Neill, L., Dec, K. L., Franks, R. R., Indelicato, P. A., LaBella, C. R., Leddy, J. J., Matuszak, J., McDonough, E. B., O'Connor, F., & Sutton, K. M. (2021). Selected issues in sport-related concussion (src|mild traumatic brain injury) for the team physician: A consensus statement. British Journal of Sports Medicine, 55(22), 1251–1261. https://doi.org/10.1136/bjsports-2021-104235
- Kleffelgaard, I., Soberg, H. L., Tamber, A.-L., Bruusgaard, K. A., Pripp, A. H., Sandhaug, M., & Langhammer, B. (2018). The effects of vestibular rehabilitation on dizziness and balance problems in patients after traumatic brain injury: A randomized controlled trial. Clinical Rehabilitation, 33(1), 74–84. https://doi.org/10.1177/0269215518791274
- Master CL, Scheiman M, Gallaway M, et al Vision diagnoses are common after concussion in adolescents. Clin Pediatr (Phila). 2016;55(3):260–267
- McCrory P, Meeuwisse W, Dvořák J, et al. Consensus statement on concussion in sport-the 5th international conference on concussion in sport held in Berlin, October 2016. Br J Sports Med 2017;51:838–47.
- Pearce KL, Sufrinko A, Lau BC, et al. Near point of convergence after a sport-related concussion: measurement reliability and relationship to neurocognitive impairment and symptoms. Am J Sports Med 2015;43:3055–61. doi:10.1177/0363546515606430
- Thomas DG, Apps JN, Hoffmann RG, et al. Benefits of strict rest after acute concussion: a randomized controlled trial. Pediatrics 2015;135:213–23. doi:10.1542/peds.2014-0966.
- Ward, A. L., & Joseph, J. R. (2022). Neuroimaging and blood biomarkers of sport concussion. *Neurosurgical Care of Athletes*, 207–216. https://doi.org/10.1007/978-3-030-88227-3_12
- Willer B, Leddy JJ. Management of concussion and post-concussion syndrome. Curr Treat Options Neurol. 2006;8(5):415-426

Questions???