

Update on the Current Recommendations on Management of Concussion:

A Review of the 6th International Consensus
Conference in Concussion in Sport

Source: Patricios JS, Schneider KJ, Dvorak J, et al. British
Journal of Sports Medicine 2023;57:695-711

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Unfortunately, I
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absolutely no financial
disclosures ☹

Amsterdam 2022 International Consensus Statement on Concussion in Sport

- Summarizes published evidence at the time of the conference
- 10 systematic reviews and the methodology paper
- New consensus process
 - Anonymous voting
 - Summaries of alternative viewpoints



Updated Definition of Sport-related Concussion

- Strongly debated during the conference and final product is a bit confusing but.....
 - Major points
 - Traumatic brain injury
 - Caused by a direct blow to the head, neck or body
 - Impulsive force transmitted to the brain
 - Neurotransmitter and metabolic cascade
 - Possible axonal injury, blood flow change and inflammation
 - Symptoms and signs may present immediately, or evolve over minutes or hours
 - Commonly resolve within days but may be prolonged.
 - No abnormality is seen on standard structural neuroimaging studies
 - May be present on functional, blood flow, or metabolic imaging
 - May or may not involve loss of consciousness
 - Clinical symptoms and signs of concussion cannot be explained solely by drug, alcohol, or medication use, other injuries (cervical or vestibular) or other comorbidities (psychological factors or coexisting medical conditions)



The 12 “R’s” of Concussion Management

- Reduce
- Recognize
- Remove
- Re-evaluate
- (Relative) Rest
- Refer
- Rehabilitate
- Recover
- Return to Learn /Return to Sport
- Reconsider / Residual Effects
- Retire
- Refine

Reduce

- Policies or rule changes
 - Limiting contact practices
 - Disallowing body checking
- Personal protective equipment
 - Mouthguards in Ice Hockey
 - No evidence for specific helmets or headgear in traditionally non-helmeted sports
- Training strategies
 - Neuromuscular training during warm-ups
- Strategies to reduce recurrent concussions
 - Mandating removal if concussion is suspected
 - Consistent Return to Play process



Recognize and Remove

- Concussion Recognition Tool (CRT-6)
 - For use by all stakeholders involved in sport
 - Urgent “Red Flag” signs
 - When to call an ambulance
 - Visible clues of concussion
 - Symptoms of concussion
 - Questions for participant or athlete related to situational awareness
 - Cognitive evaluation

CRT6™

Concussion Recognition Tool

To Help Identify Concussion in Children, Adolescents and Adults



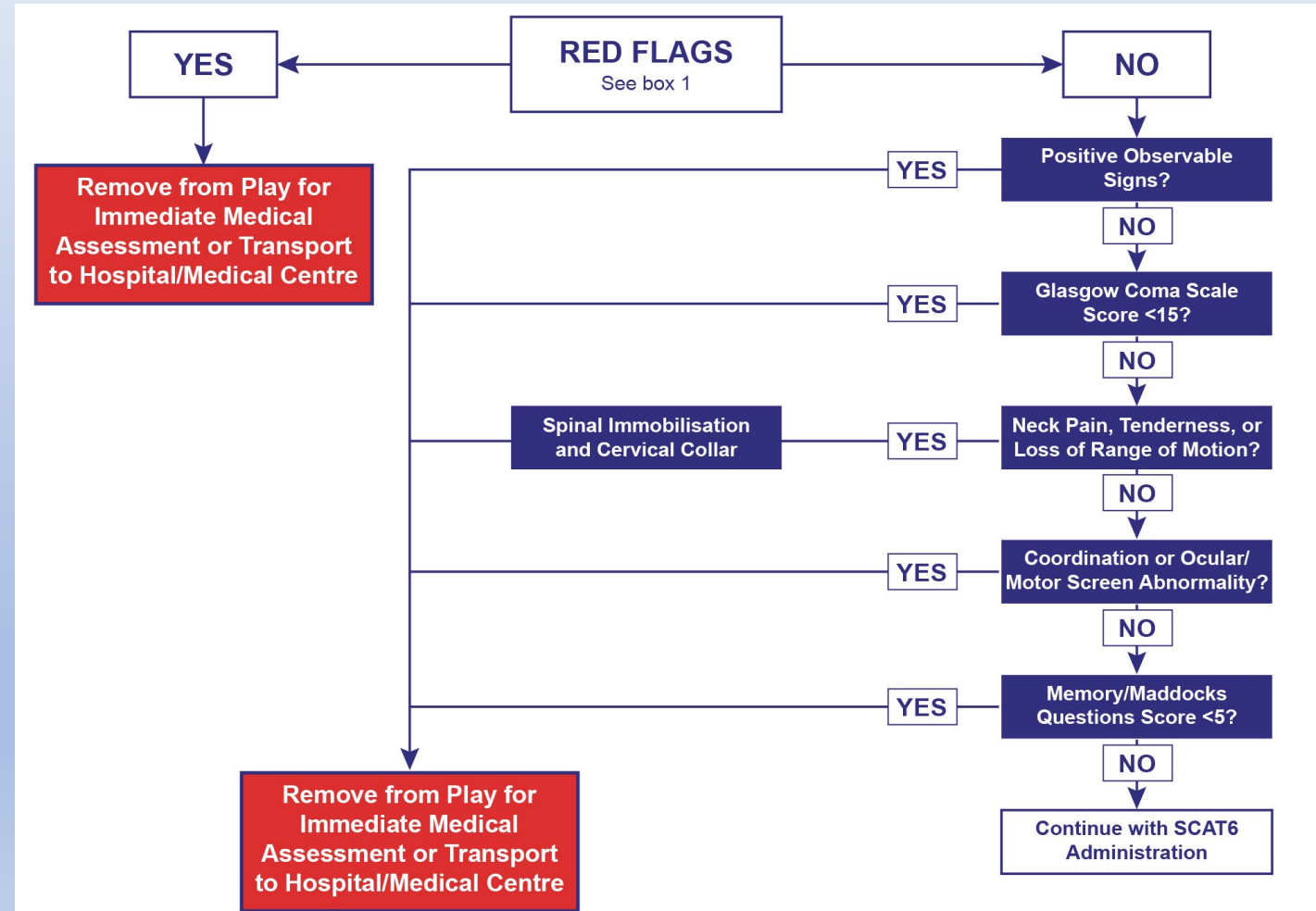
Recognize and Remove

- SCAT-6 and Child SCAT-6
 - Healthcare professionals
 - On-field use or up to 7 days s/p injury
 - Best use is < 72 hours
 - Can be done in serial fashion during first week post-injury



Components of SCAT6

- Demographics
 - Including Concussion History
- Acute Evaluation Flowchart
- On Field Assessment
 - Observable Signs
 - Glasgow Coma Scale
 - Cervical Spine
 - Coordination & Oculomotor
 - Memory via Maddocks ?'s



Components of SCAT6

- Off Field Assessment
 - (1) Athlete Background
 - (2) Symptom Evaluation
 - 22 items, 0-6/6
 - Completed by athlete
 - (3) Cognitive Screen
 - Orientation
 - Immediate Memory
 - 10 word list, 3 trials
 - Concentration
 - # series and months backwards
 - (4) Coordination and Balance Exam
 - Modified Balance Error Scoring System (mBESS)
 - Timed Tandem Gait
 - Dual Task Gait (Optional)
 - (5) Delayed Recall



SCAT5 vs SCAT6 comparison

SCAT5

- Age Adaptation
 - Minimal age specific rec's
- Cognitive Assessment
 - Both 5 and 10 word lists for immediate and delayed recall
- Maddocks Questions
 - Original version
- Balance Examination
 - Tandem Gait
 - Modified BESS

SCAT6

- Age Adaptation
 - Tailored assessments for age groups
 - Age-appropriate questions and criteria for pediatric and elderly populations
- Cognitive Assessment
 - 10-word list only, for standardization
- Maddocks Questions
 - Updated, option for sport-specific mod's
- Timer for Months in Reverse Test
- Enhanced Balance Examination
 - Tandem Gait assessment timed
 - Modified BESS unchanged
 - Dual task Gait

Re-evaluate

- SCOAT6
 - In-office assessment
 - Variety of tests for healthcare professionals to use in the office setting from 3-30 days and beyond
 - Done in serial fashion over time
- Child SCOAT6
 - Ages 8-12 years
- Computerized Neurocognitive testing
 - Interpret in the context of broader clinical findings
 - Not to be used in isolation to inform management or diagnostic decisions



Components of SCOAT6

- History of Injury
- Prior Concussion History
- PMHx of Neuro, Psych, or LD
- FHx of Neuro, Psych, or LD
- Meds
- Serial Symptom Evaluations by date
- Verbal Cognitive Tests
 - Immediate Memory
 - Digits, months in reverse



Components of SCOAT6

- Orthostatic Vital signs
- Cervical Spine Assessment
- Neurologic Assessment
- Balance Assessment
 - mBESS +/- foam
 - Timed Tandem Gait
 - Complex Tandem Gait
 - Eyes open then closed
 - Dual Task Gait
 - Heel-toe + serial 7's or months in reverse
- Modified Vestibulo-ocular motor screening (mVOMS)
- Anxiety, Depression, Sleep screens
- Delayed Word Recall
- Computerized Neurocognitive testing
- Graded Aerobic Exercise Testing



(Relative) Rest

- Only the initial 24 to 48 hours following injury
 - **NO MORE COCOONING!**
 - Light physical activity (such as walking) as tolerated in the initial 48 hours
 - Limited screen time initially but...
 - Aerobic exercise within 2-10 days
 - Helps reduce recovery time
 - Prevents symptom persistence
 - “Active rehab”
 - Progressive increases in exercise intensity with no risk of head impact
 - Slight worsening of Sx’s (1-2/10) is acceptable with Sx’s improving < 1 hr



Refer

- Referral to specialist in concussion management
 - Patients with symptoms lasting > 4 weeks



Rehabilitate

- Cervicovestibular Rehab
 - Neck strain/sprain
 - Common contributor to persisting headaches post-concussion
 - Addresses balance dysfunction after concussion
- Rec'd for patients with dizziness, neck pain, headaches, and/or balance problems > 10 days after concussion
- Performed in combination with aerobic exercise



Recover

- Plan of Care for Recovery
 - Remains Individualized
 - Based upon serial assessments by healthcare professionals
- New technologies
 - Blood, saliva, fMRI, DTI
 - None ready for “Prime Time”



Return to Learn

- Environmental adjustments,
 - Modified school attendance
 - Rest breaks from cognitive tasks
 - Limited screen time
 - Sit at front of classroom
- Physical adjustments
 - No PE class, no recess
- Curriculum adjustments
 - Extra time to complete coursework
 - Preprinted class notes.
- Testing adjustments
 - Delaying testing
 - Extended time for completion

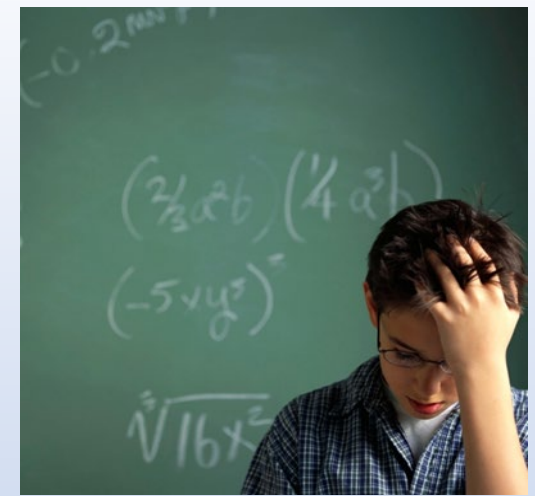


Table 1
Return-to-learn (RTL) strategy

Step	Mental activity	Activity at each step	Goal
1	Daily activities that do not result in more than a mild exacerbation* of symptoms related to the current concussion	Typical activities during the day (eg, reading) while minimising screen time. Start with 5–15 min at a time and increase gradually.	Gradual return to typical activities
2	School activities	Homework, reading or other cognitive activities outside of the classroom.	Increase tolerance to cognitive work
3	Return to school part time	Gradual introduction of schoolwork. May need to start with a partial school day or with greater access to rest breaks during the day.	Increase academic activities
4	Return to school full time	Gradually progress in school activities until a full day can be tolerated without more than mild* symptom exacerbation.	Return to full academic activities and catch up on missed work

- Following an initial period of relative rest (24–48 hours following an injury at Step 1), athletes can begin a gradual and incremental increase in their cognitive load. Progression through the strategy for students should be slowed when there is more than a mild and brief symptom exacerbation.
- *Mild and brief exacerbation of symptoms is defined as an increase of no more than 2 points on a 0–10 point scale (with 0 representing no symptoms and 10 the worst symptoms imaginable) for less than an hour when compared with the baseline value reported prior to cognitive activity.

Return to Sport

- First 3 steps are “treatment” phase
 - “Active” Rehab
 - mild worsening of symptoms (1-2 points on a 0-10 scale) during and after non-contact activities are permitted provided they resolve within one hour
- Final 3 steps of Return-to-Sport strategy
 - Requirements for medical clearance for final 3 steps
 - Resolution of concussion-related Sx’s
 - No clinical signs at rest or after physical activity
 - Normal Neuro exam
 - Normal vestibular/vestibulo-ocular exam
 - Normal cognitive testing

Step	Exercise Strategy	Activity at Each Step	Goal
1	Symptom-limited activity.	Daily activities that do not exacerbate symptoms (e.g., walking).	Gradual reintroduction of work/school.
2	Aerobic exercise 2A – Light (up to approx. 55% max HR) then 2B – Moderate (up to approximately 70% max HR)	Stationary cycling or walking at slow to medium pace. May start light resistance training that does not result in more than mild and brief exacerbation* of concussion symptoms.	Increase heart rate.
3	Individual sport-specific exercise NOTE: if sport-specific exercise involves any risk of head impact, medical determination of readiness should occur prior to step 3.	Sport-specific training away from the team environment (e.g., running, change of direction and/or individual training drills away from the team environment). No activities at risk of head impact.	Add movement, change of direction.
Steps 4-6 should begin after resolution of any symptoms, abnormalities in cognitive function, and any other clinical findings related to the current concussion, including with and after physical exertion.			
4	Non-contact training drills.	Exercise to high intensity including more challenging training drills (e.g., passing drills, multiplayer training). Can integrate into team environment.	Resume usual intensity of exercise, coordination, and increased thinking.
5	Full contact practice.	Participate in normal training activities.	Restore confidence and assess functional skills by coaching staff.
6	Return to sport.	Normal game play.	

Reconsider potential Residual Effects

- Long-term systematic reviews performed
 - Mental Illness / Suicide
 - Neither amateur nor professional athletes partaking in collision sports at increased risk
 - Neurological disease
 - Amateur athletes → No increased risk
 - Professional football and soccer player with slightly higher risk of some
 - Discussed Chronic Traumatic Encephalopathy (CTE)
 - Call for more collaborative research
 - Many factors affect long-term brain health such as heart health, smoking, high blood pressure, genetics, etc.



Retire

- Extremely complex, individualized decision
- Multi-disciplinary team of clinicians is required and may include
 - Concussion specialist
 - Neurologist
 - Neuropsychologist
 - Psychologist
 - Physical Therapist
- Transitioning to lower risk sports
 - Maintain health positive effects of exercise upon physical and mental health

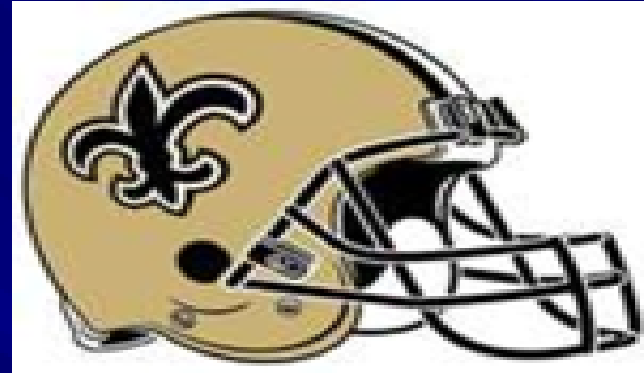


Refine

- Recommendations for specific populations
 - Para-athlete
 - Rec's specific to varying disabilities
 - Children and Adolescents
 - Specific tools for ages 8-12 years
 - Child SCAT6 and Child SCOAT6
 - Return to Learn/School is the Priority
 - Can be done simultaneous with Return to Sport



Thank You!! Questions?



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Physical Therapist Role In Sports Related Concussion Recovery

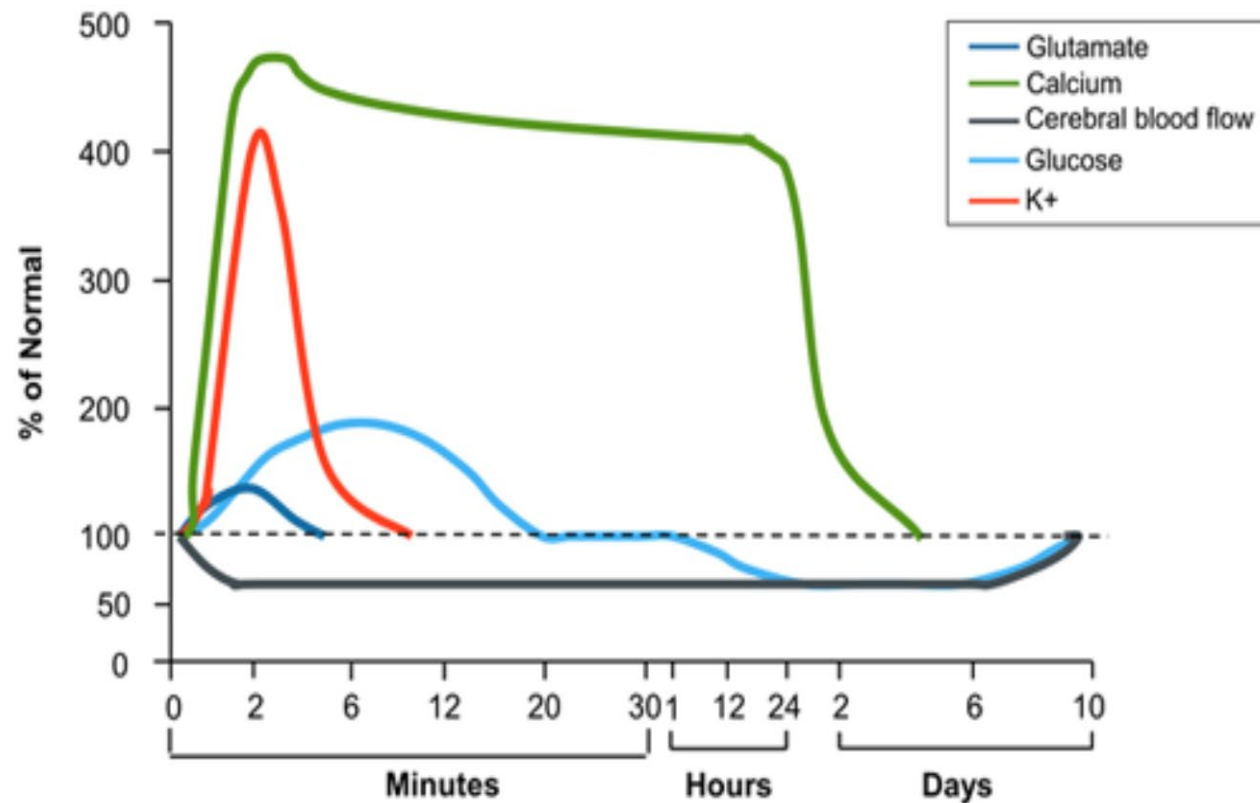
Caitlyn Beltrani PT, DPT, SCS, FAAOMPT
May 15, 2024

- I have no financial disclosures or conflicts of interest with the presented material in this presentation.

Concussion Defined

“Sport-related concussion is a traumatic brain injury caused by a direct blow to the head, neck or body resulting in an impulsive force being transmitted to the brain that occurs in sports and exercise-related activities.” ¹

Neurometabolic Cascade Following Cerebral Concussion/mTBI



From Giza CC, et al.^[10]

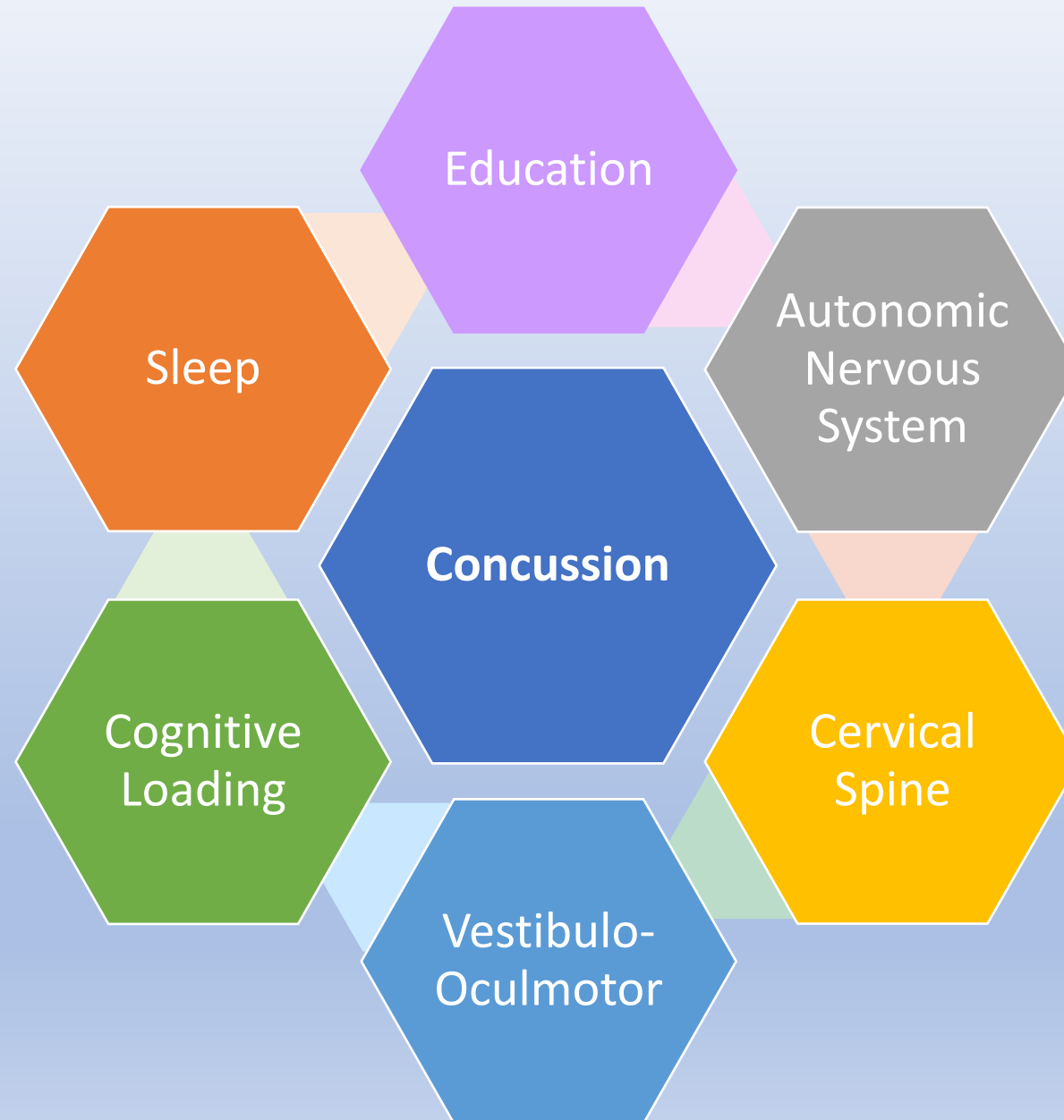
Referral to Physical Therapy

“Patients that do not return to their pre-injury neurological baseline after the expected timeframe are **at risk for further co-morbidities including *aerobic deconditioning, chronic pain, anxiety disorder, depression***, as well as ***poor academic performance***”

Symptom Domains

1. Symptoms (e.g. somatic, headache)
2. Physical Signs (e.g. loss of consciousness, amnesia)
3. Behavior Changes (e.g. irritability)
4. Cognitive Impairments (e.g. slowed reaction times)
5. Sleep Disturbances (e.g. insomnia)

Clinic Domains



Autonomic Nervous System Dysfunction

Symptoms:

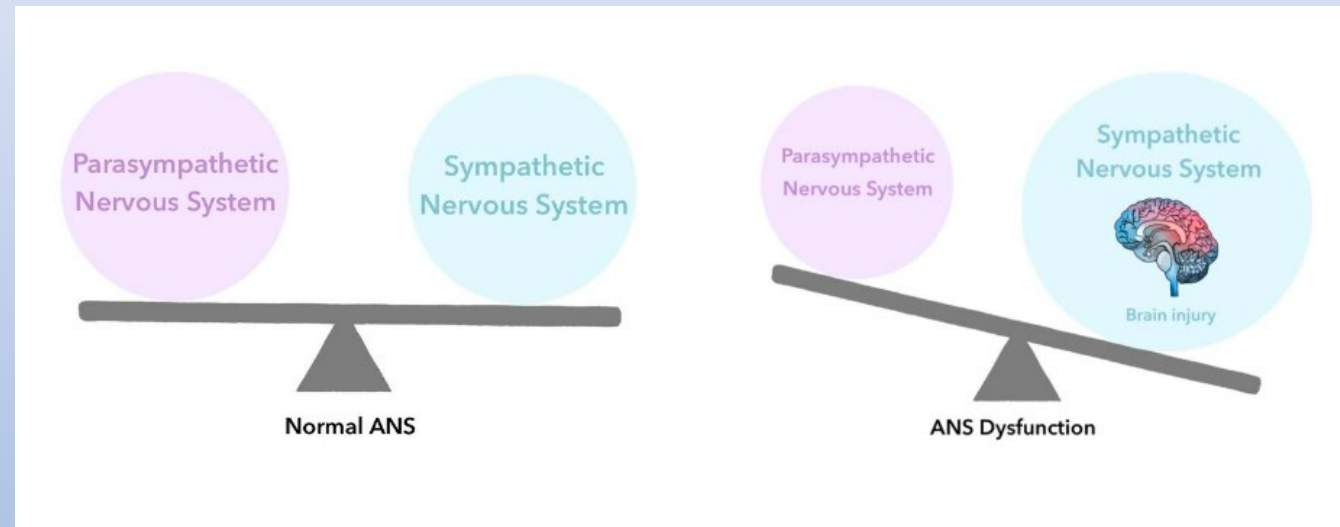
- Dizziness with position changes
- Altered response to cognitive loading and/or physical activity causing symptoms
- Changed temperature response
- Nausea or changes in appetite

Examination:

- Heart Rate Variability Measurements
- Buffalo Concussion Treadmill Test

Treatment:

- Education
- Graded sub-symptomatic daily exercise



Autonomic Nervous System Dysfunction

Symptoms:

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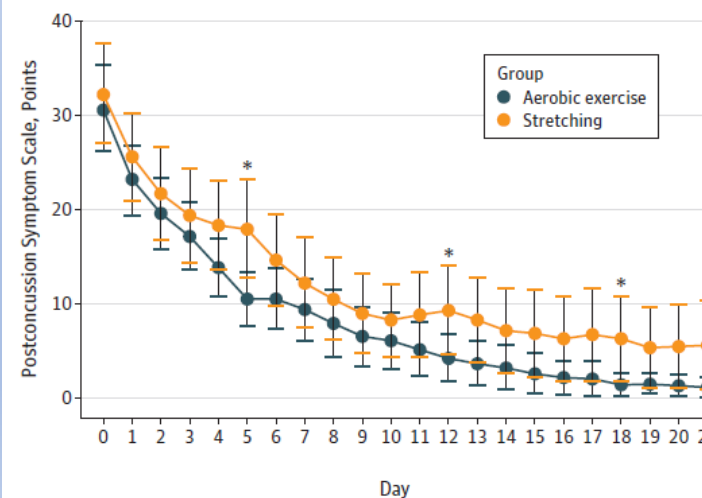
- Education
- Graded sub-symptomatic daily exercise

JAMA Pediatrics | Original Investigation

Early Subthreshold Aerobic Exercise for Sport-Related Concussion A Randomized Clinical Trial

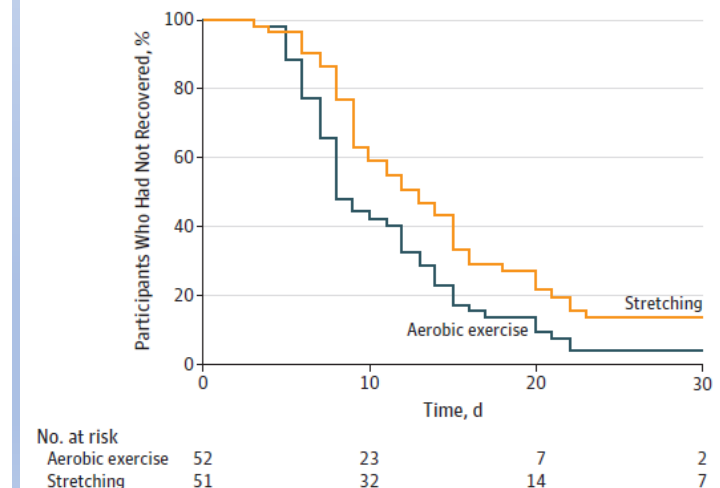
John J. Leddy, MD; Mohammad N. Haider, MD; Michael J. Ellis, MD; Rebekah Mannix, MD; Scott R. Darling, MD; Michael S. Freitas, MD; Heidi N. Suffoletto, MD; Jeff Leiter, PhD; Dean M. Cordingley, MSc; Barry Willer, PhD

Figure 3. Daily Symptom Severity Score per the Postconcussion Symptom Scale



Bars indicate 95% CIs; asterisks, a significant difference on analysis of variance.

Figure 2. Kaplan-Meier Estimates of Time to Recovery



Survival analysis comparing groups; the aerobic exercise group recovered significantly faster than the stretching group after adjusting for age, sex, time from injury to first clinical visit, and concussion history ($z = 2.82$; $P = .005$).

- **Symptoms**

- **Cervical Spine**

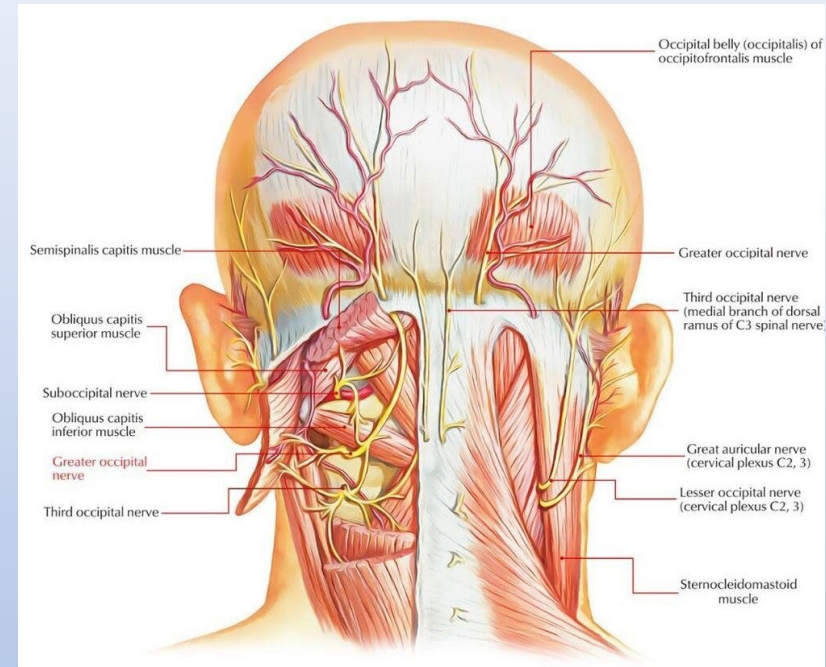
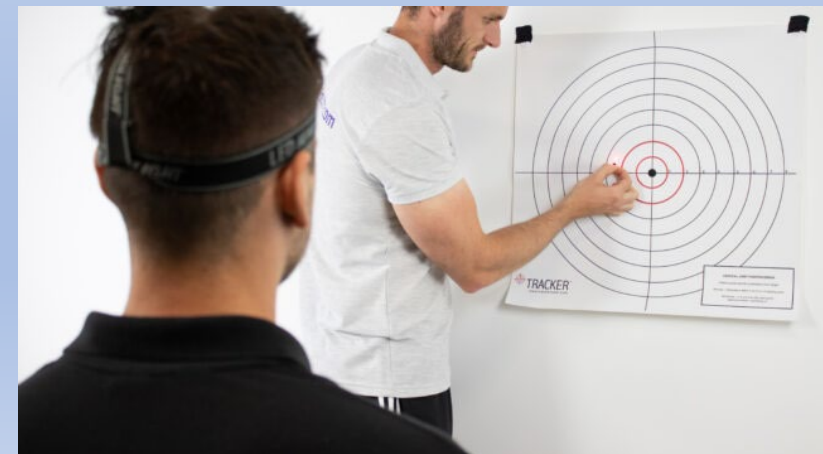
- Headache (ramus horn)
- Dizziness
- Symptoms with neck movement
- Neck Pain*
- Neck stiffness*

- **Evaluation:**

- Cervical Spine Manual Assessment
- Cervical Joint Position Error Test
- Deep Neck Flexor Endurance Testing

- **Treatment:**

- Education
- Manual therapy to restore normal joint motion
- Deep neck flexor strengthening
- Address dysfunction of the Scapulothoracic region
- Neck proprioceptive training



- **Symptoms**

- **Cervical Spine**

- Headache (rams-horn)
- Dizziness
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Interventions: Neck Pain with Movement Coordination Impairments

Acute

For patients with **acute** neck pain with movement coordination impairments (including WAD):

- B** Clinicians should provide the following:
 - Education of the patient to
 - Return to normal, nonprovocative preaccident activities as soon as possible
 - Minimize use of a cervical collar
 - Perform postural and mobility exercises to decrease pain and increase ROM
 - Reassurance to the patient that recovery is expected to occur within the first 2 to 3 months.

- B** Clinicians should provide a multimodal intervention approach including manual mobilization techniques plus exercise (eg, strengthening, endurance, flexibility, postural, coordination, aerobic, and functional exercises) for those patients expected to experience a moderate to slow recovery with persistent impairments.

- C** Clinicians may provide the following for patients whose condition is perceived to be at low risk of progressing toward chronicity:

- A single session consisting of early advice, exercise instruction, and education
- A comprehensive exercise program (including strength and/or endurance with/without coordination exercises)
- Transcutaneous electrical nerve stimulation (TENS)

- F** Clinicians should monitor recovery status in an attempt to identify those patients experiencing delayed recovery who may need more intensive rehabilitation and an early pain education program.

Interventions: Neck Pain with Headaches

Acute

For patients with **acute** neck pain with headache:

- B** Clinicians should provide supervised instruction in active mobility exercise.

- C** Clinicians may provide C1–2 self-sustained natural apophyseal glide (self-SNAG) exercise.

Subacute

For patients with **subacute** neck pain with headache:

- B** Clinicians should provide cervical manipulation and mobilization.

- C** Clinicians may provide C1–2 self-SNAG exercise.

Chronic

For patients with **chronic** neck pain with headache:

- B** Clinicians should provide cervical or cervicothoracic manipulation or mobilizations combined with shoulder girdle and neck stretching,

• Vestibulo-Ocular System

• Symptoms

- Headache (rams-horn)
- Dizziness
 - Symptoms with neck movement
 - Difficulty reading or using device
 - Difficulty in school
 - Balance issues
 - Vision Problems

• Evaluation:

- Vestibular Ocular Motor Screen
 - Convergence*
- Balance Assessment (i.e. mBess, Sway)

• Treatment:

- Education
- Convergence retraining
- Oculomotor retraining
- Balance training

• End Stage Treatment:

- VOR Retraining

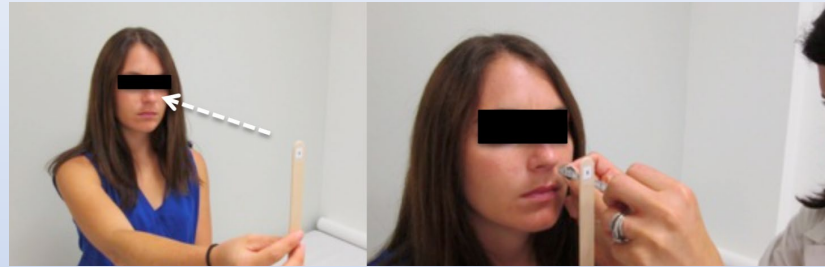
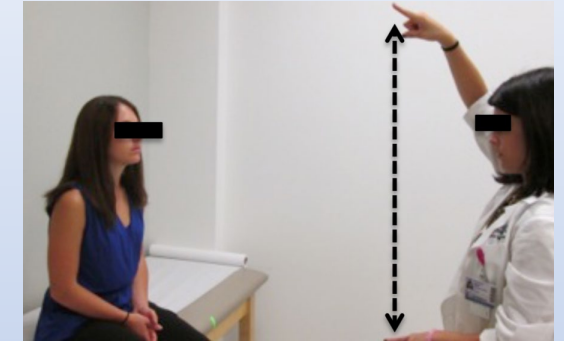
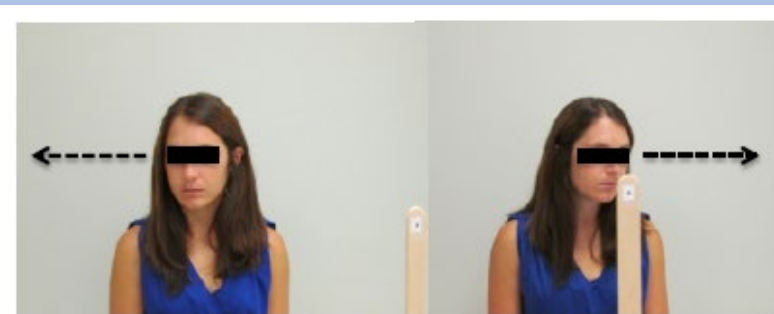


Figure 5. Horizontal VOR.

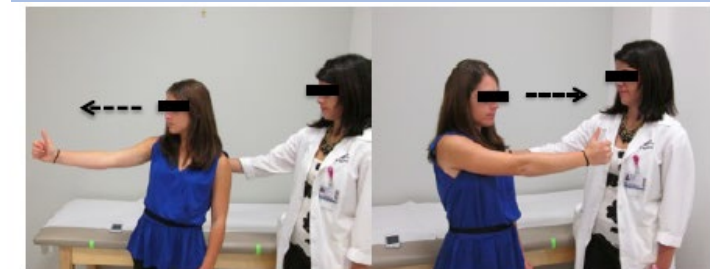


Figure 7. VMS.

- Vestibulo-Ocular System

- Symptoms

- Headache (rams-horn)
- Dizziness
 - Symptoms with neck movement
 - Difficulty reading or using device
 - Difficulty in school
 - Balance issues
 - Vision Problems

- Evaluation:

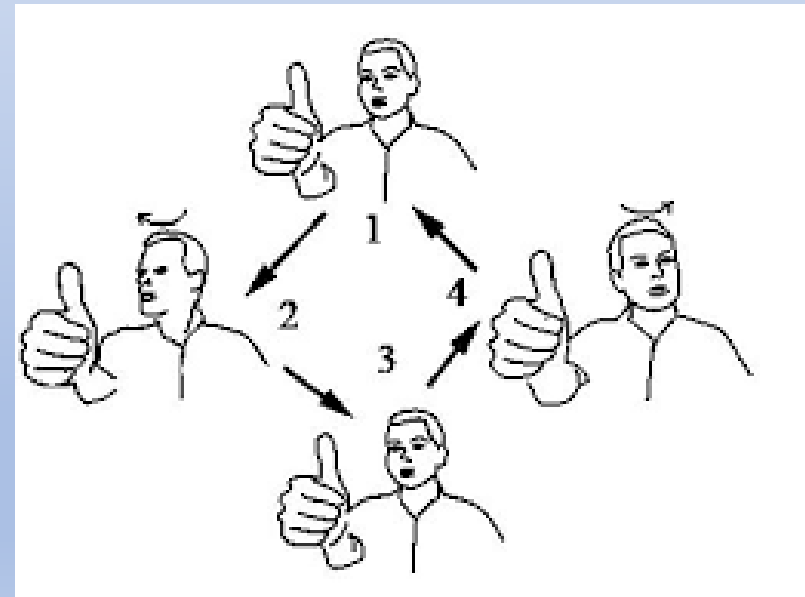
- Vestibular Ocular Motor Screen
 - Convergence*
- Balance Assessment (i.e. mBess, Sway)

- Treatment:

- Education
- Convergence retraining
- Oculomotor retraining
- Balance training

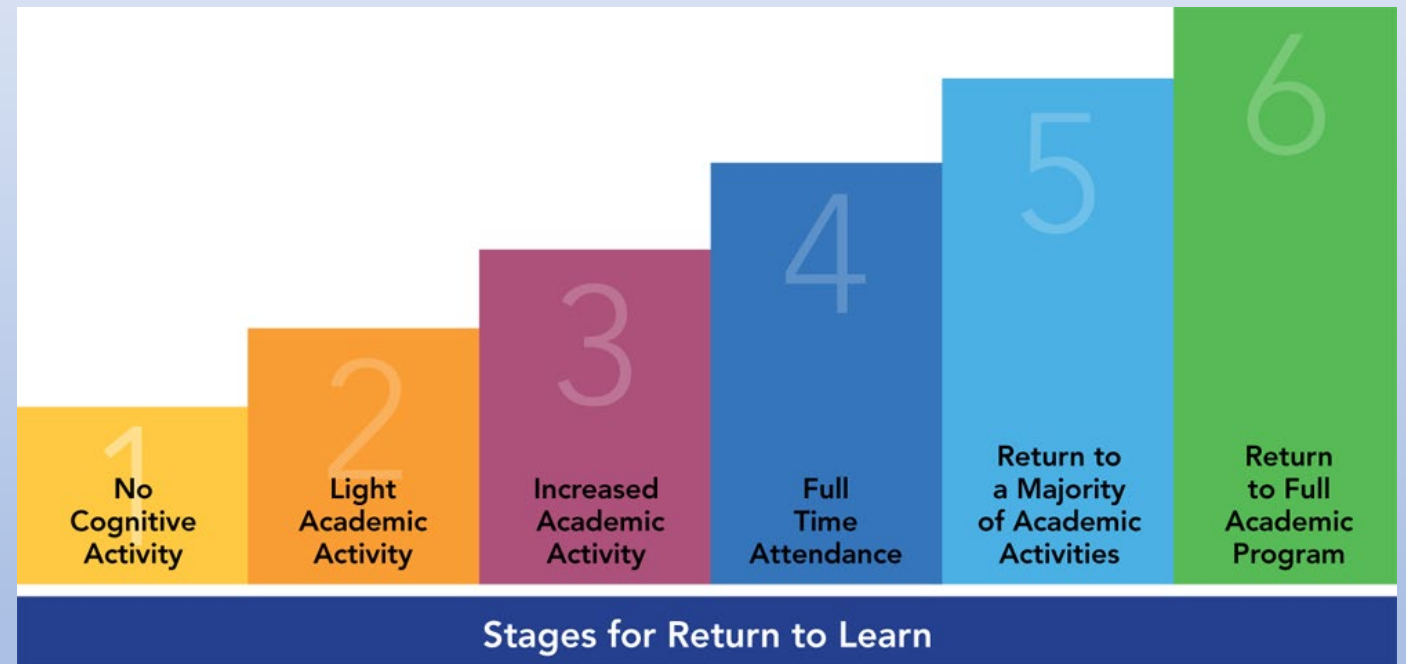
- End Stage Treatment:

- VOR Retraining



Cognitive Loading &

- **Symptoms**
 - Difficulty focusing
 - Difficulty remembering
 - Grade or work quality suffering
 - Feeling mentally foggy
- **Evaluation:**
 - Acute: Sideline SCAT-6
 - Chronic: Speech therapist evaluation
- **Treatment:**
 - Education on symptom management
 - Education on progressive return to work or learn plan
- **Chronic Stage Treatment:**
 - Speech Therapy Referral



Influence of Sleep Dysfunction on Concussion Assessment Outcomes Among Adolescent Athletes After Concussion and Healthy Controls

Nicholas A. Blaney, BS,* Alicia Trbovich, PhD,† Nathan Ernst, PsyD,† Shawn R. Eagle, PhD,* Michael W. Collins, PhD,*† and Anthony P. Kontos, PhD*†

Abstract

Background: Sleep dysfunction (SD) is associated with a high symptom burden and lower neurocognitive performance after concussion and on baseline testing without injury. However, few studies have compared concussed athletes and controls with and without SD on clinical outcomes. **Objective:** To evaluate differences in clinical outcomes among both concussed athletes and matched controls with and without SD. **Design:** Retrospective cross-sectional study. **Participants:** Participants aged 12 to 20 years were recruited from a concussion clinic (n = 50 patients) and research registry/flyers (n = 50 healthy age-/sex-matched controls). Participants were categorized by self-reported SD into one of 4 groups: sport-related concussion (SRC) + SD, SRC only, SD only, and controls. **Main Outcome Measures:** Post-Concussion Symptom Scale (PCSS), Vestibular/Oculomotor Screening (VOMS), and neurocognitive testing (Immediate Postconcussion Assessment Cognitive Test). **Results:** Compared with the SRC only group, the SRC + SD group performed worse on all neurocognitive domains, had a higher total symptom score, and endorsed more symptoms on most VOMS items. In addition, the SRC + SD group was at an increased likelihood of having at least 1 abnormal VOMS item compared with SRC only group. The SRC only group had neurocognitive test scores and symptom reports statistically similar to the SD only group. **Conclusion:** Sleep dysfunction after concussion is related to worse neurocognitive performance and higher concussion symptom reporting. This study extended findings to suggest vestibular symptomology is worse among athletes with SD after injury compared to injured athletes without SD. Similar performances on concussion assessments for the SRC only and SD only groups suggest SD may appear similar to clinical presentation of concussion, even at baseline in the absence of SRC.

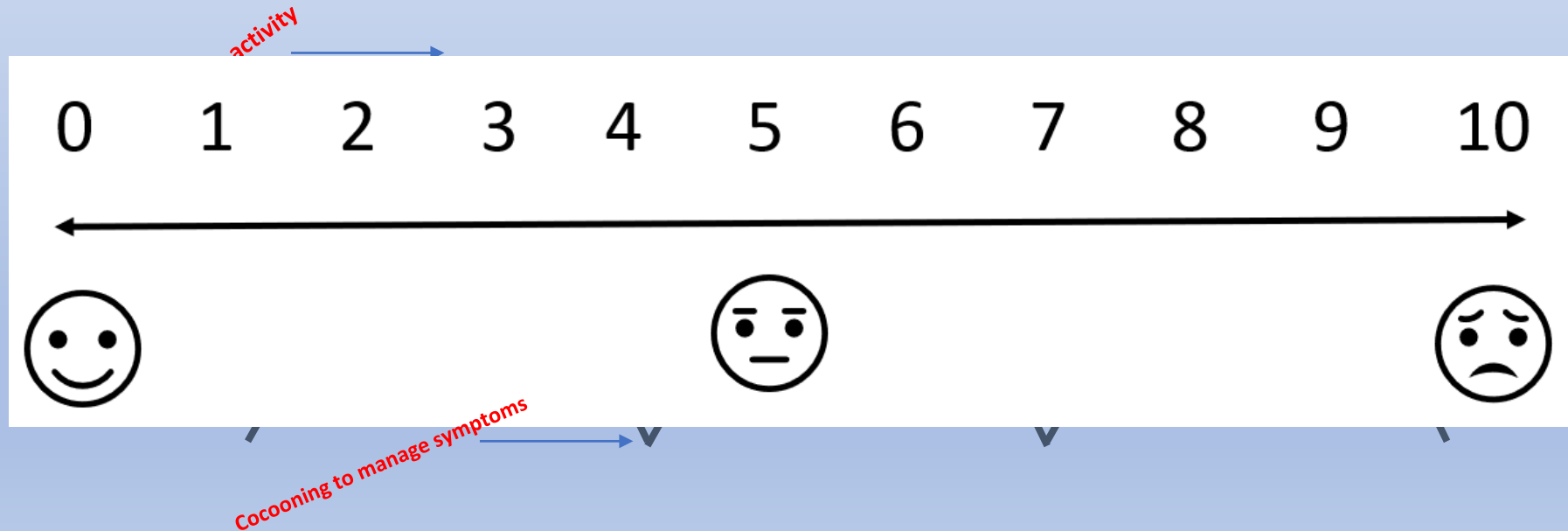
Key Words: concussion, vestibular, neurocognitive, clinical outcomes, sleep dysfunction

(Clin J Sport Med 2020;00:1–7)

- 50-75% of the treatment

Education

- **Symptom Management**
 - Extremely important!
 - Do not increase more than 2-3 points from baseline symptom scale (VAS 0-10)
 - Continue with all activities of daily living, school and sub-symptomatic prescribed exercises



Return to Play

Rehabilitation Stage	Functional Exercise at Each Stage of Rehabilitation	Objective of Each Stage
1. No Activity	Symptom limited physical and cognitive rest	Recovery
2. Light aerobic exercise	Walking, swimming, or stationary cycling keeping intensity <70% maximum permitted heart rate	Increase heart rate Perform for 30 minutes
3. Sport-specific exercise	Skating drills in hockey. Running drills in soccer. No head impact activities.	Add movement Perform for 30 minutes
4. Non-contact training drills	Progression to more complex training drills. For example, passing drills in football and soccer	Improve exercise, coordination, and increase cognitive load
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	Normal game play	

- Physical therapy treatment of a concussion is multi-factorial and complex
- Exercise is the first line of treatment for an acute concussion
- Referral to physical therapy should occur early if the patient continues to complain of headaches, dizziness and neck pain
- Most concussion patients have some form of a cervical dysfunction that must be addressed prior to completing high level vestibular retraining through skilled evaluation and subsequent treatment
- Sleep is equally as important as exercise. Too little or too much sleep can mimic the signs and symptoms of a concussion



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