Concussion: An Update

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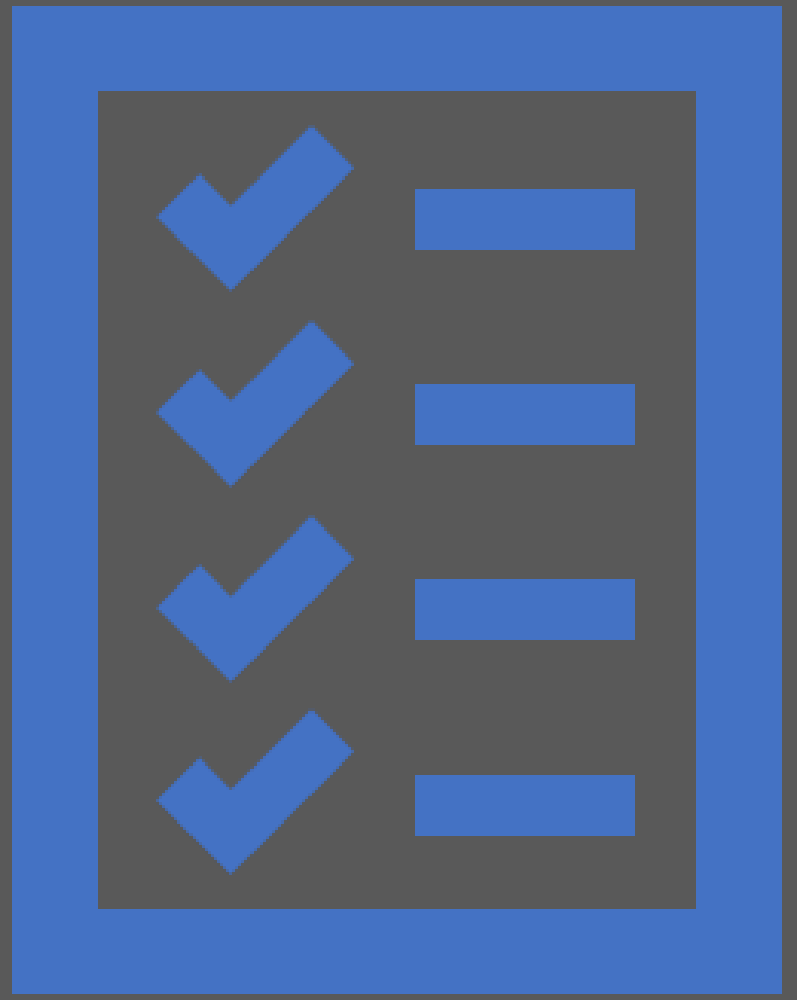
Objectives

- History of the definition of concussion
- Recognition of concussion in a school setting
- Diagnosis of concussion
- Individualized modifications and accommodations



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Concussion- Definition

American Academy of Neurology defines concussion as clinical syndrome characterized by immediate and transient alteration in brain function, including alteration of mental status and level of consciousness, resulting from mechanical force or trauma

AMERICAN ACADEMY OF NEUROLOGY®

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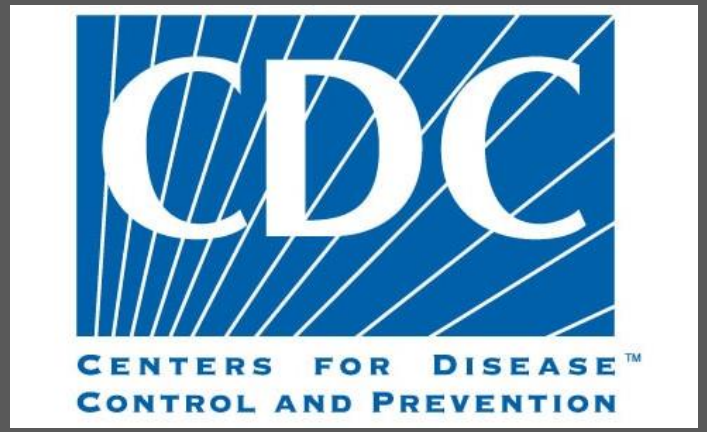
Concussion- Definition

CDC defines a traumatic brain injury (TBI) as a disruption in the normal function of the brain that can be caused by a bump, blow, or jolt to the head, or penetrating head injury.



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Previous Concussion Definitions

1. *Concussion may be caused by either a direct blow to the head or a blow to elsewhere on the body, with an "impulsive" force transmitted to the head.*

2. *Concussion typically results in the rapid onset of functional neurologic impairment which is of brief duration and resolves spontaneously.*

3. *Concussion may result in neuropathological changes, but the acute clinical symptoms reflect a functional, rather than a structural disturbance*

4. *Concussion results in a graded set of clinical symptoms that may or may not involve loss of consciousness. Resolution of the clinical and cognitive symptoms typically follows a sequential course; however, it is important to note that, in a small percentage of cases, post-concussive symptoms may be prolonged*

5. *No abnormality on standard structural neuroimaging studies is seen in concussion.*

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Changes to the Definition

1. *Concussion may be caused by either a direct blow to the head or a blow to elsewhere on the body, with an "impulsive" force transmitted to the head.*

2. *Concussion typically results in the rapid onset of short lived impairment in neurological function that resolves spontaneously. However, in some cases, signs and symptoms evolve over a number of minutes to hours.*

3. *Concussion may result in neuropathological changes, but the acute clinical symptoms reflect a functional, rather than a structural injury and as such. No abnormality is seen on standard structural neuroimaging.*

4. *Concussion results in range of clinical signs and symptoms that may or may not involve loss of consciousness. Resolution of clinical and cognitive features typically follows a sequential course. However, in some cases may be prolonged.*

5. *Clinical signs and symptoms cannot be explained by drug, alcohol, or medication use, other injuries (such as cervical injuries, peripheral vestibular dysfunction) or other comorbidities (psychological factors or coexisting medical conditions)*

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International Conference on Concussion Consensus Statements

- Meeting 1 (2001) Vienna:
  - Establish consensus on sport
- Meeting 2 (2004) Prague:
  - SCAT developed and establish RTP
- Meeting 3 (2008) Zurich:
  - SCAT 2 developed
- Meeting 4 (2012) Zurich:
  - SCAT3 and Child SCAT3 developed
- Meeting 5 (2016) Berlin:
  - SCAT5 and Child SCAT5 developed
- Meeting 6 (2022) Amsterdam:
  - SCAT6/Child SCAT6, SCOAT6/Child SCOAT6, inclusion of CRT6, and SMHAT

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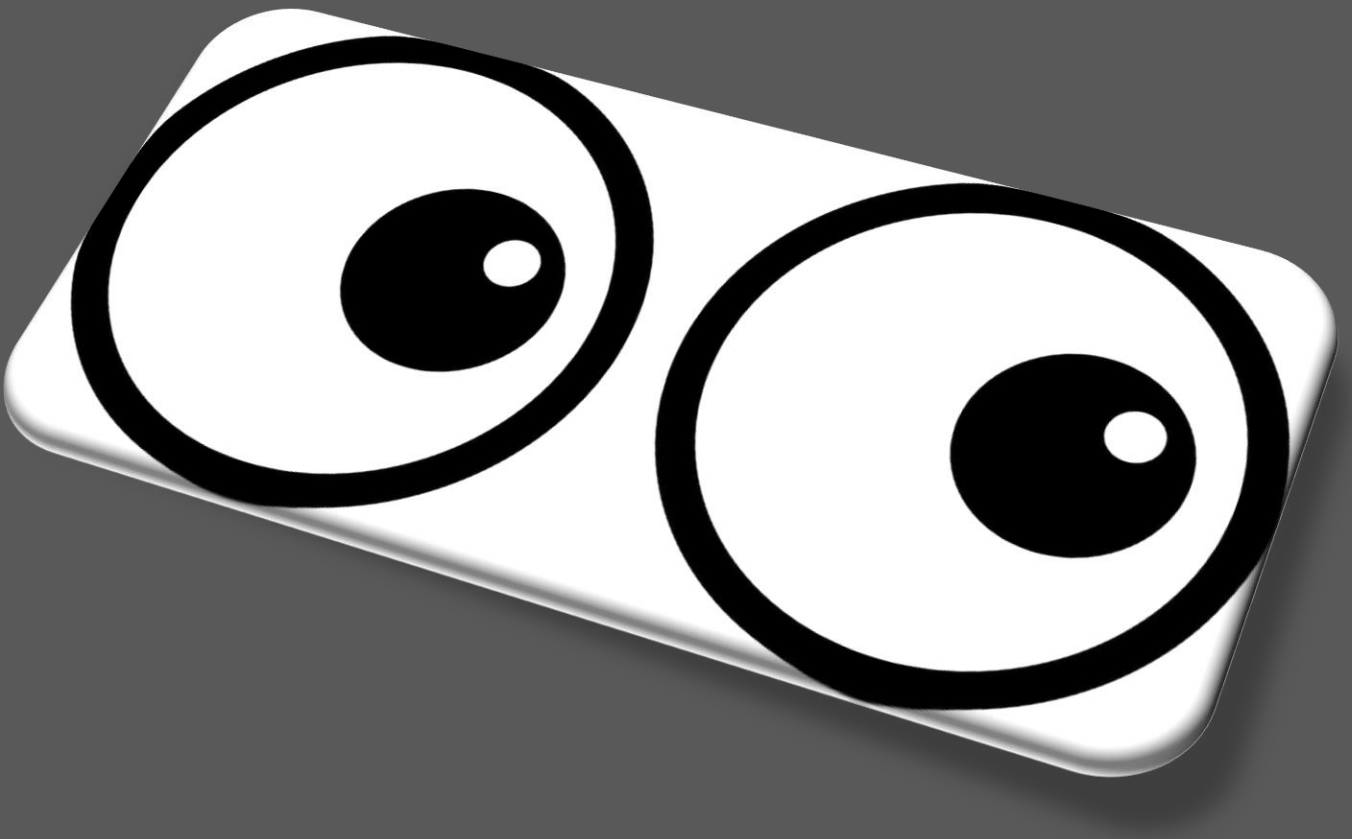
Be on the look out!



<u>THIS</u> month the next consensus statement and tools should be published and free for all!

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New Consensus Statement

Full document: [Consensus statement on concussion in sport: the 6th International Conference on Concussion in Sport–Amsterdam, October 2022 (bmj.com)]

*Updated forms will be in the *Tools* section at the end of the presentation

Consensus statement on concussion in sport: the 6th International Conference on Concussion in Sport–Amsterdam, October 2022

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ABSTRACT

For over two decades, the Concussion in Sport Group has held meetings and developed five international statements on concussion in sport. This 6th statement summarises the processes and outcomes of the 6th International Conference on Concussion in Sport held in Amsterdam on 27–30 October 2022 and should be read in conjunction with the (1) methodology paper that outlines the consensus process in detail and (2) 10 systematic reviews that informed the conference outcomes. Over 3½ years, author groups conducted systematic reviews of predetermined priority topics relevant to concussion in sport. The format of the conference, expert panel meetings and workshops to revise or develop new clinical assessment tools, as described in the methodology paper, evolved from previous consensus meetings with several new components. Apart from this consensus statement, the conference process yielded revised tools including the Concussion Recognition Tool-6 (CRT6) and Sport Concussion Assessment Tool-6 (SCAT6, Child SCAT6), as well as a new tool, the Sport Concussion Office Assessment Tool-6 (SCOAT6, Child SCOAT6). This consensus process also integrated new features including a focus on the para athlete, the athlete's perspective, concussion-specific medical ethics and matters related to both athlete retirement and the potential long-term effects of SRC, including neurodegenerative disease. This statement summarises evidence-informed principles of concussion prevention, assessment and management, and emphasises those areas requiring more research.

Check for updates

To cite: Patricios JS, Schneider KJ, Dvorak J, *et al*. *Br J Sports Med* 2023;**57**:695–711.

INTRODUCTION

This Amsterdam 2022 International Consensus Statement on Concussion in Sport (Statement) builds on previous Concussion in Sport Group (CISG) statements with the goal of updating current recommendations for sport-related concussion (SRC) through an evidence-informed consensus methodology. The purpose of this Statement is to provide a summary of the evidence and practice recommendations based on science and expert panel consensus recommendations at the time of the conference. Additional outputs of the consensus process include freely available evidence-informed tools to assist in the detection and assessment of SRC, including the Concussion Recognition Tool-6 (CRT6), Sport Concussion Assessment Tool-6 (SCAT6), Child SCAT6, Sport Concussion Office Assessment Tool-6 (SCOAT6) and Child SCOAT6. Apart from this Statement, in the interest of knowledge translation, the tools are free to distribute in their original formats.

This Statement is developed for the healthcare professional (HCP) involved in the care of athletes at risk of SRC or who have sustained a suspected SRC at any level of sport (ie, recreational to professional). The authors recognise that differences in geography, healthcare structure and culture are important considerations when implementing the principles presented. Thus, this Statement provides recommendations that can be adapted for different sport, clinical and cultural environments and is not meant to be used as a prescriptive guideline. We also recognise that the science of concussion continues to evolve, and the Amsterdam Statement reflects the state of the evidence at the time of the Consensus Conference and will need to be updated as new scientific information emerges. Also included are recommendations for future research where notable gaps in the literature have been identified. Although this Statement provides recommendations and is a summary of the consensus process, it should be read in combination with the 10 systematic reviews and methodology papers that informed the consensus process and outcomes.

MEDICOLEGAL CONSIDERATIONS

This Statement is not intended as a clinical practice directive or legal standard of care and should not

Causes of Concussion

Falls

Motor Vehicle Crash

Unintentional (being struck by or against something)

Assaults

Sports

- **Boys**: Football, LAX
- **Girls**: Soccer, Basketball, Cheer

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Pathophysiology

- The hit causes neurons to stretch, then causing a metabolic cascade
- Depolarization releases excitatory neurotransmitters
  - Increase calcium, decrease magnesium
- Ion pump activity increases to restore homeostasis
- Energy crisis continues
  - Decrease cerebral blood flow
  - Increase in calcium disrupts mitochondrial function (decr. ATP)
  - HYPERglycolysis to create more ATP
  - Que lactate
- Decrease in metabolism from 6hrs to 2-4weeks

(Prins & Hovda 2009; Giza &Hova 2001; Giza & Hova 2014)

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Signs & Symptoms

Physical

- Headache
- Balance Problems
- Visual Problems
- Fatigue
- Photophobia
- Phonophobia
- Incoordination
- Dizziness

Sleep

- Drowsiness
- Sleeping more/less than usual
- Difficulty falling asleep.

Cognitive

- Feeling mentally foggy
- Feeling slowed down
- Poor concentration
- Inattention
- Poor memory
- Answers slowly
- Repeats questions

Emotional

- Irritable
- Sadness/Depression
- Emotional Liability
- Nervousness/ Anxiety

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RED FLAGS

Escalating headache

Seizures

Repeated vomiting

Abnormal speech

Personality changes (increased irritability)

Vision Changes

Decreasing consciousness (difficult to arouse)

Worsening confusion (can't recognize people or places)

Suspected C-spine injury

Weakness, numbness in extremities

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RED FLAGS

Escalating headache

Seizures

Repeate

Abnormal speech

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Vision Changes

Decreasing consciousness (difficult to arouse)

Worsening confusion (can't ble or places)

Suspected C-spine injury

Weakness, numbness in extremities

Transport to ED

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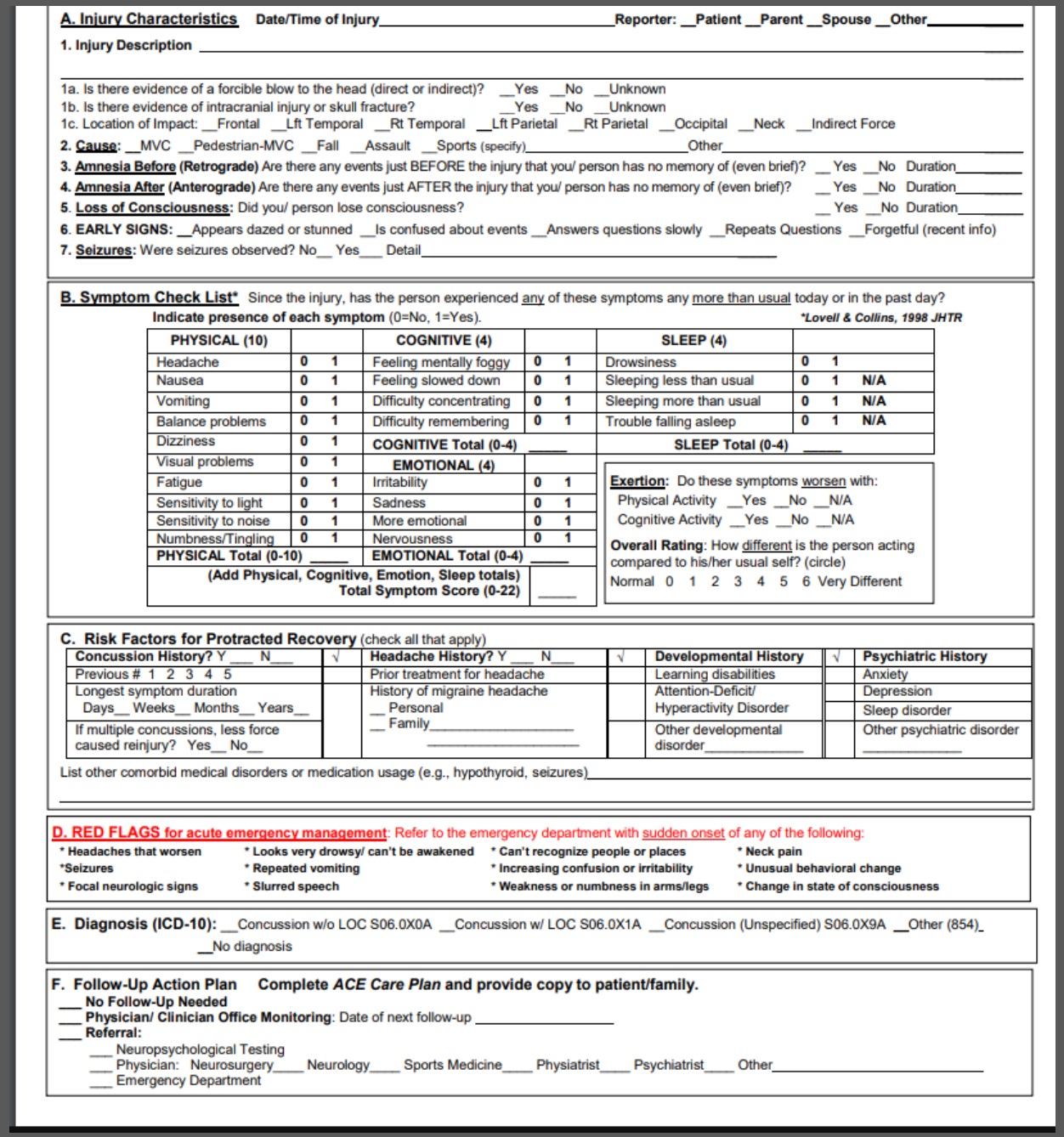
Assessment

- Acute (on field, sideline, office, home, etc.)
  - Ask for them to recount what happened
  - Symptoms
  - Assess cervical spine (tenderness, ROM)
  - Memory (5-10 words)
  - Orientation (Where are we? Who is your teacher?)
  - Concentration (7s, 3s)
  - Balance/Coordination (double leg, tandem, single leg)
  - VOMS screening/ visual issues
  - Remove from sideline for further evaluation

ACE Form (Acute Concussion Evaluation)



A. Injury Characteristics Date/Time of Injury_____ Reporter: __Patient __Parent __Spouse __Other_____

1. Injury Description _____

1a. Is there evidence of a forcible blow to the head (direct or indirect)? __Yes __No __Unknown
1b. Is there evidence of intracranial injury or skull fracture? __Yes __No __Unknown
1c. Location of Impact: __Frontal __Lft Temporal __Rt Temporal __Lft Parietal __Rt Parietal __Occipital __Neck __Indirect Force
2. **Cause**: __MVC __Pedestrian-MVC __Fall __Assault __Sports (specify)_____ Other_____
3. **Amnesia Before (Retrograde)** Are there any events just BEFORE the injury that you/ person has no memory of (even brief)? __Yes __No Duration_____
4. **Amnesia After (Anterograde)** Are there any events just AFTER the injury that you/ person has no memory of (even brief)? __Yes __No Duration_____
5. **Loss of Consciousness**: Did you/ person lose consciousness? __Yes __No Duration_____
6. **EARLY SIGNS:** __Appears dazed or stunned __Is confused about events __Answers questions slowly __Repeats Questions __Forgetful (recent info)
7. **Seizures**: Were seizures observed? No__ Yes___ Detail_____

B. Symptom Check List* Since the injury, has the person experienced any of these symptoms any more than usual today or in the past day?
Indicate presence of each symptom (0=No, 1=Yes). **Lovell & Collins, 1998 JHTR*

PHYSICAL (10)		COGNITIVE (4)		SLEEP (4)		
Headache	0 1	Feeling mentally foggy	0 1	Drowsiness	0 1	
Nausea	0 1	Feeling slowed down	0 1	Sleeping less than usual	0 1	N/A
Vomiting	0 1	Difficulty concentrating	0 1	Sleeping more than usual	0 1	N/A
Balance problems	0 1	Difficulty remembering	0 1	Trouble falling asleep	0 1	N/A
Dizziness	0 1	COGNITIVE Total (0-4)	____	SLEEP Total (0-4)	____	
Visual problems	0 1	EMOTIONAL (4)				
Fatigue	0 1	Irritability	0 1			
Sensitivity to light	0 1	Sadness	0 1			
Sensitivity to noise	0 1	More emotional	0 1			
Numbness/Tingling	0 1	Nervousness	0 1			
PHYSICAL Total (0-10) ____		EMOTIONAL Total (0-4) ____				
(Add Physical, Cognitive, Emotion, Sleep totals) Total Symptom Score (0-22)	____					

Exertion: Do these symptoms worsen with:
Physical Activity __Yes __No __N/A
Cognitive Activity __Yes __No __N/A

Overall Rating: How different is the person acting compared to his/her usual self? (circle)
Normal 0 1 2 3 4 5 6 Very Different

C. Risk Factors for Protracted Recovery (check all that apply)

Concussion History? Y___ N___	√	Headache History? Y___ N___	√	Developmental History	√	Psychiatric History
Previous # 1 2 3 4 5		Prior treatment for headache		Learning disabilities		Anxiety
Longest symptom duration Days__ Weeks__ Months__ Years__		History of migraine headache __ Personal __ Family_____		Attention-Deficit/ Hyperactivity Disorder		Depression
						Sleep disorder
If multiple concussions, less force caused reinjury? Yes__ No__				Other developmental disorder_____		Other psychiatric disorder _____

List other comorbid medical disorders or medication usage (e.g., hypothyroid, seizures)_____

D. RED FLAGS for acute emergency management: Refer to the emergency department with sudden onset of any of the following:

* Headaches that worsen	* Looks very drowsy/ can't be awakened	* Can't recognize people or places	* Neck pain
*Seizures	* Repeated vomiting	* Increasing confusion or irritability	* Unusual behavioral change
* Focal neurologic signs	* Slurred speech	* Weakness or numbness in arms/legs	* Change in state of consciousness

E. Diagnosis (ICD-10): __Concussion w/o LOC S06.0X0A __Concussion w/ LOC S06.0X1A __Concussion (Unspecified) S06.0X9A __Other (854)_
__No diagnosis

F. Follow-Up Action Plan **Complete *ACE Care Plan* and provide copy to patient/family.**
___ **No Follow-Up Needed**
___ **Physician/ Clinician Office Monitoring**: Date of next follow-up _____
___ **Referral:**
___ Neuropsychological Testing
___ Physician: Neurosurgery____ Neurology____ Sports Medicine____ Physiatrist____ Psychiatrist____ Other_____
___ Emergency Department

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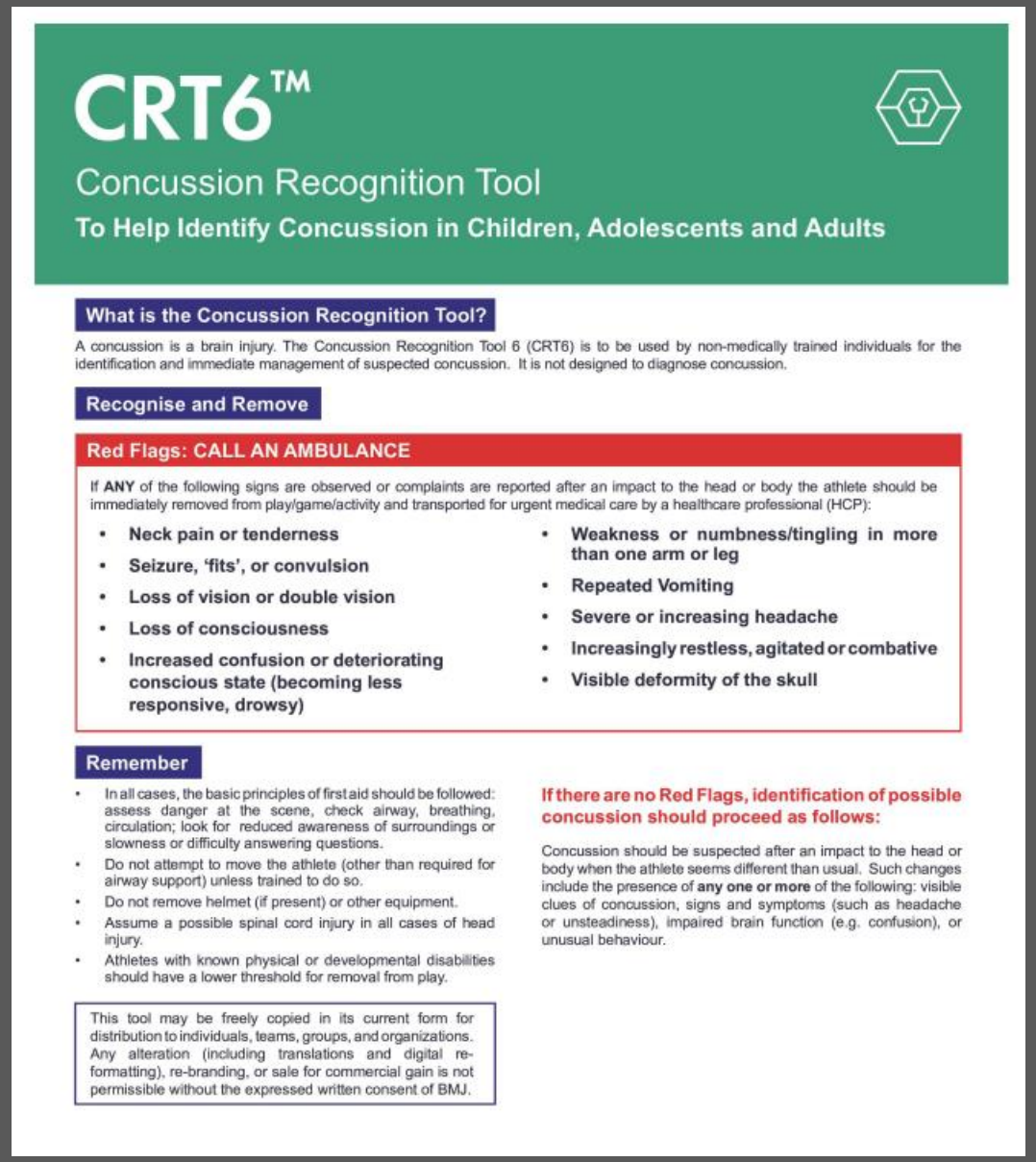
Concussion Recognition Tool 6



CRT6™

Concussion Recognition Tool

To Help Identify Concussion in Children, Adolescents and Adults

What is the Concussion Recognition Tool?

A concussion is a brain injury. The Concussion Recognition Tool 6 (CRT6) is to be used by non-medically trained individuals for the identification and immediate management of suspected concussion. It is not designed to diagnose concussion.

Recognise and Remove

Red Flags: CALL AN AMBULANCE

If **ANY** of the following signs are observed or complaints are reported after an impact to the head or body the athlete should be immediately removed from play/game/activity and transported for urgent medical care by a healthcare professional (HCP):

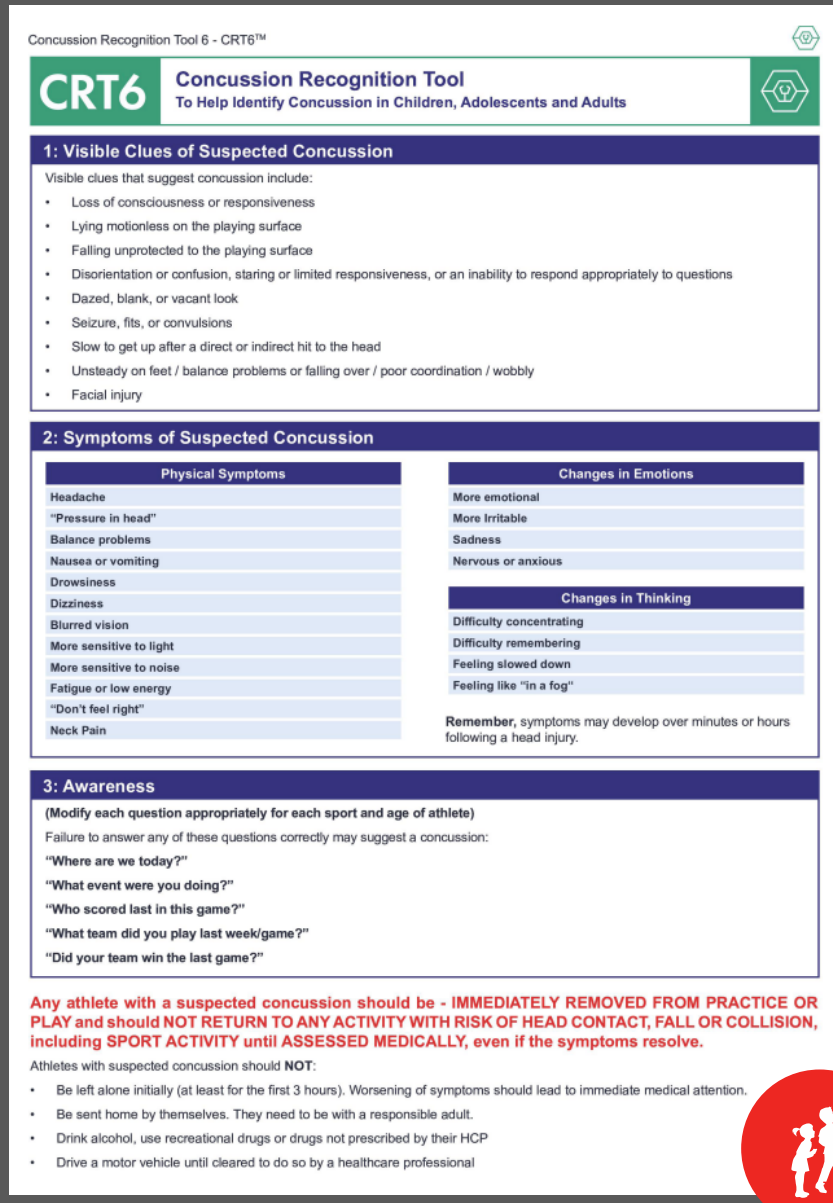
- **Neck pain or tenderness**
- **Seizure, 'fits', or convulsion**
- **Loss of vision or double vision**
- **Loss of consciousness**
- **Increased confusion or deteriorating conscious state (becoming less responsive, drowsy)**
- **Weakness or numbness/tingling in more than one arm or leg**
- **Repeated Vomiting**
- **Severe or increasing headache**
- **Increasingly restless, agitated or combative**
- **Visible deformity of the skull**

Remember

- In all cases, the basic principles of first aid should be followed: assess danger at the scene, check airway, breathing, circulation; look for reduced awareness of surroundings or slowness or difficulty answering questions.
- Do not attempt to move the athlete (other than required for airway support) unless trained to do so.
- Do not remove helmet (if present) or other equipment.
- Assume a possible spinal cord injury in all cases of head injury.
- Athletes with known physical or developmental disabilities should have a lower threshold for removal from play.

If there are no Red Flags, identification of possible concussion should proceed as follows:

Concussion should be suspected after an impact to the head or body when the athlete seems different than usual. Such changes include the presence of **any one or more** of the following: visible clues of concussion, signs and symptoms (such as headache or unsteadiness), impaired brain function (e.g. confusion), or unusual behaviour.



CRT6 Concussion Recognition Tool
To Help Identify Concussion in Children, Adolescents and Adults

1: Visible Clues of Suspected Concussion

Visible clues that suggest concussion include:

- Loss of consciousness or responsiveness
- Lying motionless on the playing surface
- Falling unprotected to the playing surface
- Disorientation or confusion, staring or limited responsiveness, or an inability to respond appropriately to questions
- Dazed, blank, or vacant look
- Seizure, fits, or convulsions
- Slow to get up after a direct or indirect hit to the head
- Unsteady on feet / balance problems or falling over / poor coordination / wobbly
- Facial injury

2: Symptoms of Suspected Concussion

Physical Symptoms
Headache
"Pressure in head"
Balance problems
Nausea or vomiting
Drowsiness
Dizziness
Blurred vision
More sensitive to light
More sensitive to noise
Fatigue or low energy
"Don't feel right"
Neck Pain

Changes in Emotions
More emotional
More Irritable
Sadness
Nervous or anxious

Changes in Thinking
Difficulty concentrating
Difficulty remembering
Feeling slowed down
Feeling like "in a fog"

Remember, symptoms may develop over minutes or hours following a head injury.

3: Awareness

(Modify each question appropriately for each sport and age of athlete)

Failure to answer any of these questions correctly may suggest a concussion:

"Where are we today?"

"What event were you doing?"

"Who scored last in this game?"

"What team did you play last week/game?"

"Did your team win the last game?"

Any athlete with a suspected concussion should be - IMMEDIATELY REMOVED FROM PRACTICE OR PLAY and should NOT RETURN TO ANY ACTIVITY WITH RISK OF HEAD CONTACT, FALL OR COLLISION, including SPORT ACTIVITY until ASSESSED MEDICALLY, even if the symptoms resolve.

Athletes with suspected concussion should **NOT**:

- Be left alone initially (at least for the first 3 hours). Worsening of symptoms should lead to immediate medical attention.
- Be sent home by themselves. They need to be with a responsible adult.
- Drink alcohol, use recreational drugs or drugs not prescribed by their HCP
- Drive a motor vehicle until cleared to do so by a healthcare professional

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Athletes: On Field Management

- Any athlete suspected of having a concussion should be immediately removed from play for screening by a healthcare professional
- If concussion is diagnosed: there is no same day return
- In the state of Alabama, by law, you must be released/ cleared by a physician to return to sport

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Assessment in the ED

- Clinical diagnosis…
  - Some are obvious - LOC, confusion, trouble with speech
  - Many are not: emotional lability, focus/concentration
  - No definitive lab test(s) – blood tests, breathalyzer, etc.
  - No imaging study
    - **Head CT/MRI does not rule in or out a concussion!**
      - **Concussion is a METABOLIC issue**

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Avoiding Common Concussion Management Pitfalls

- Prolonged “House Arrest”/ “Cocoon Therapy”
- Academic Overload/ Stress to get everything caught up
- Not Acknowledging the emotional component
- Returning to Athletics/Physical Activities too early

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Initial Concussion Management

"Relative rest"

- **Studies are now suggesting that strict rest may prolong symptoms**
- In school with accommodations
  - out only 1-2 days
- Involved in daily activities to tolerance
- Physical rest

Sleep schedule

Early, *subsymptom threshold* exercise is now showing best recovery

Step-wise progression back to activity (cognitive & physical) as patient becomes asymptomatic

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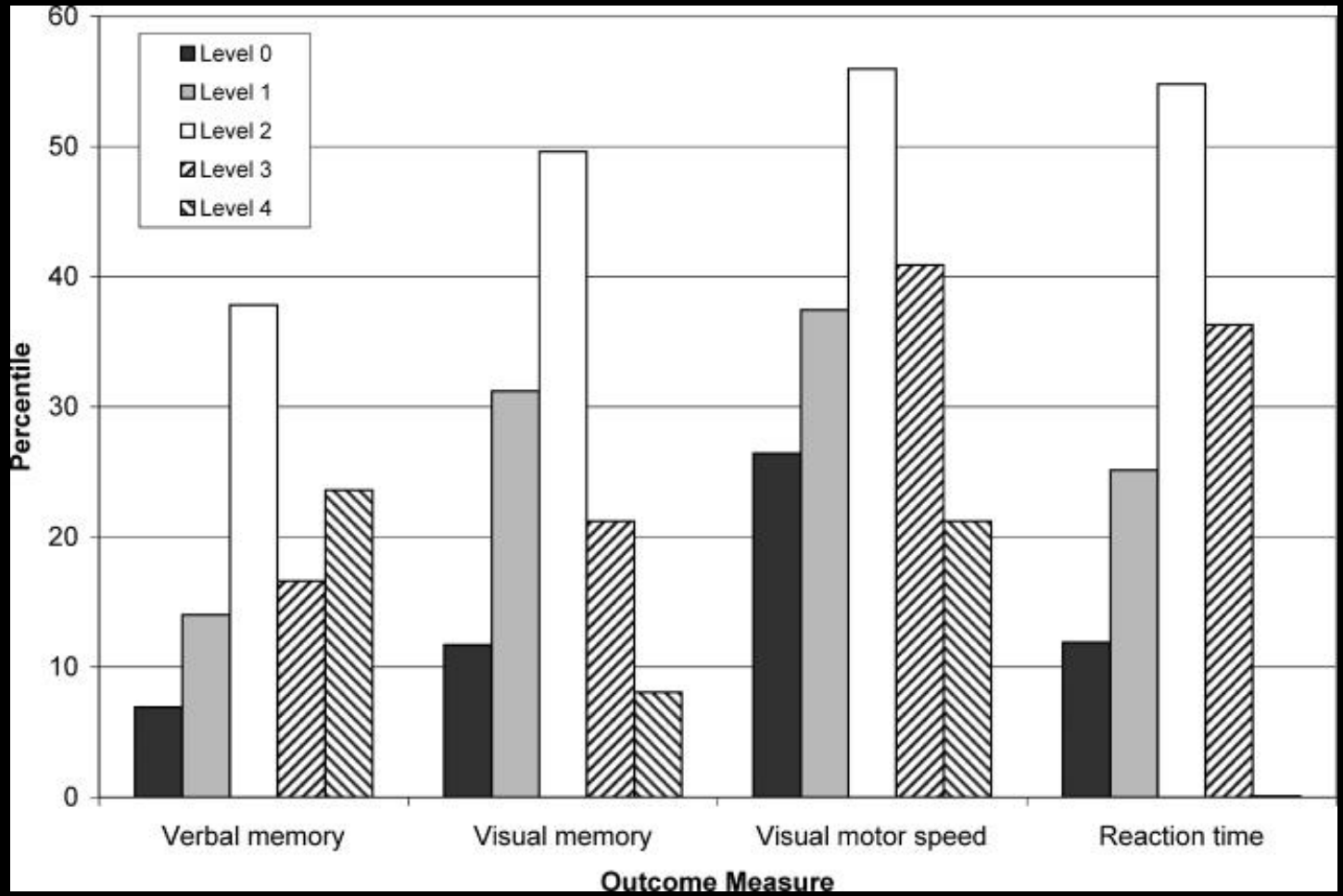
Early exercise intervention:

Concussion in sports: postconcussive activity levels, symptoms, and neurocognitive performance



"…those (athletes) engaging in moderate (level 2) of activity demonstrated the best performance…"

Majerske CW, Mihalik JP, Ren D, Collins MW, Reddy CC, Lovell MR, Wagner AK (2008)

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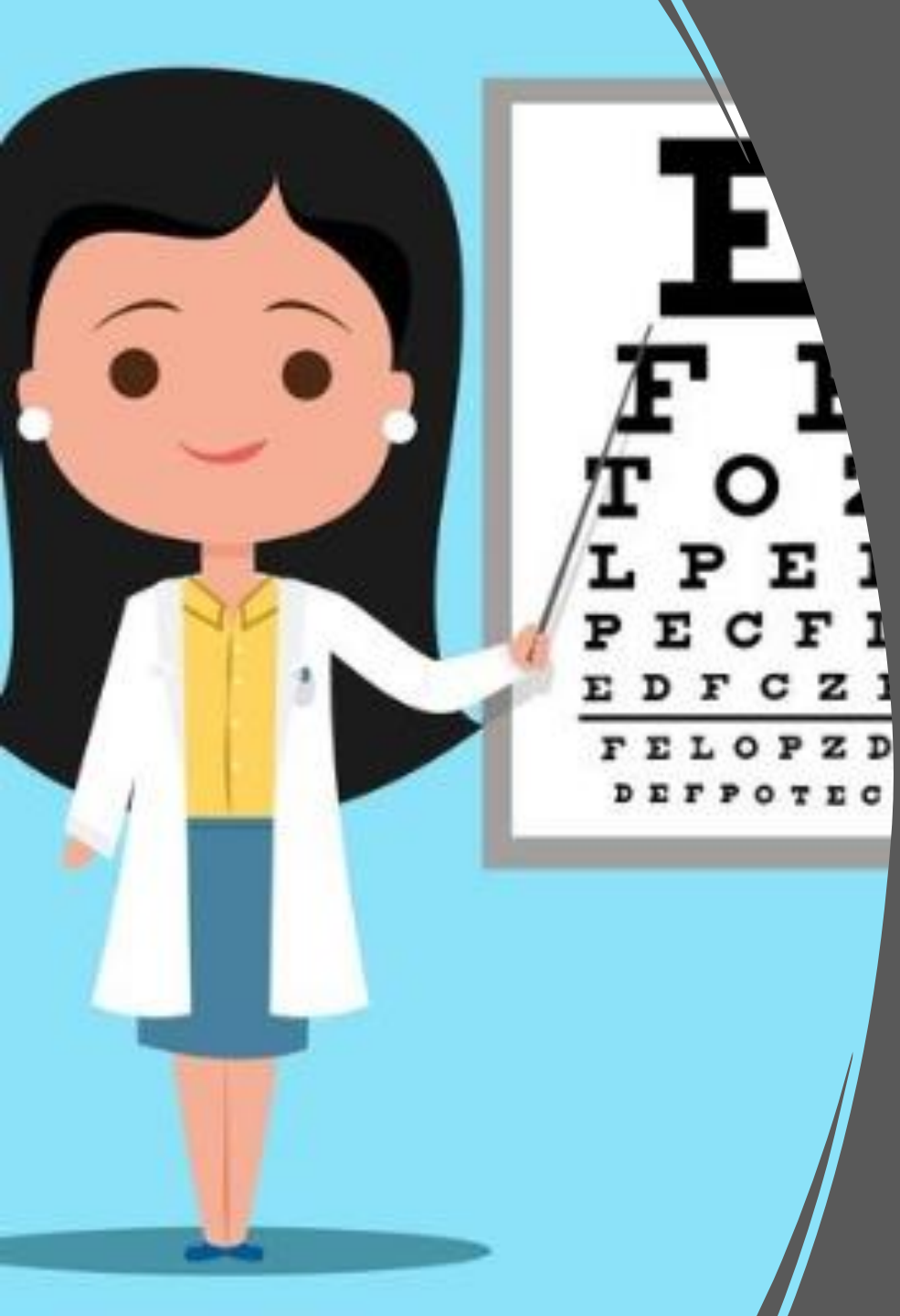

Physical Exam

- There may or may not be physical exam findings
- Standard neurologic exam including reflexes is usually normal
- However, may have:
  - Nystagmus
  - Difficulties with smooth eye movements
  - Changes in pupil reaction
  - Difficulties with coordination/balance
  - Convergence insufficiency
  - VestibularOccular dysfunction

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Assessment (in clinic)

- Detailed history
- SCOAT6/SCAT6 (13yo and older)
- Child SCOAT6/Child SCAT6 (8-12yo)
- mBESS on Bertec
- VOMS
- POTS check (blood pressures)

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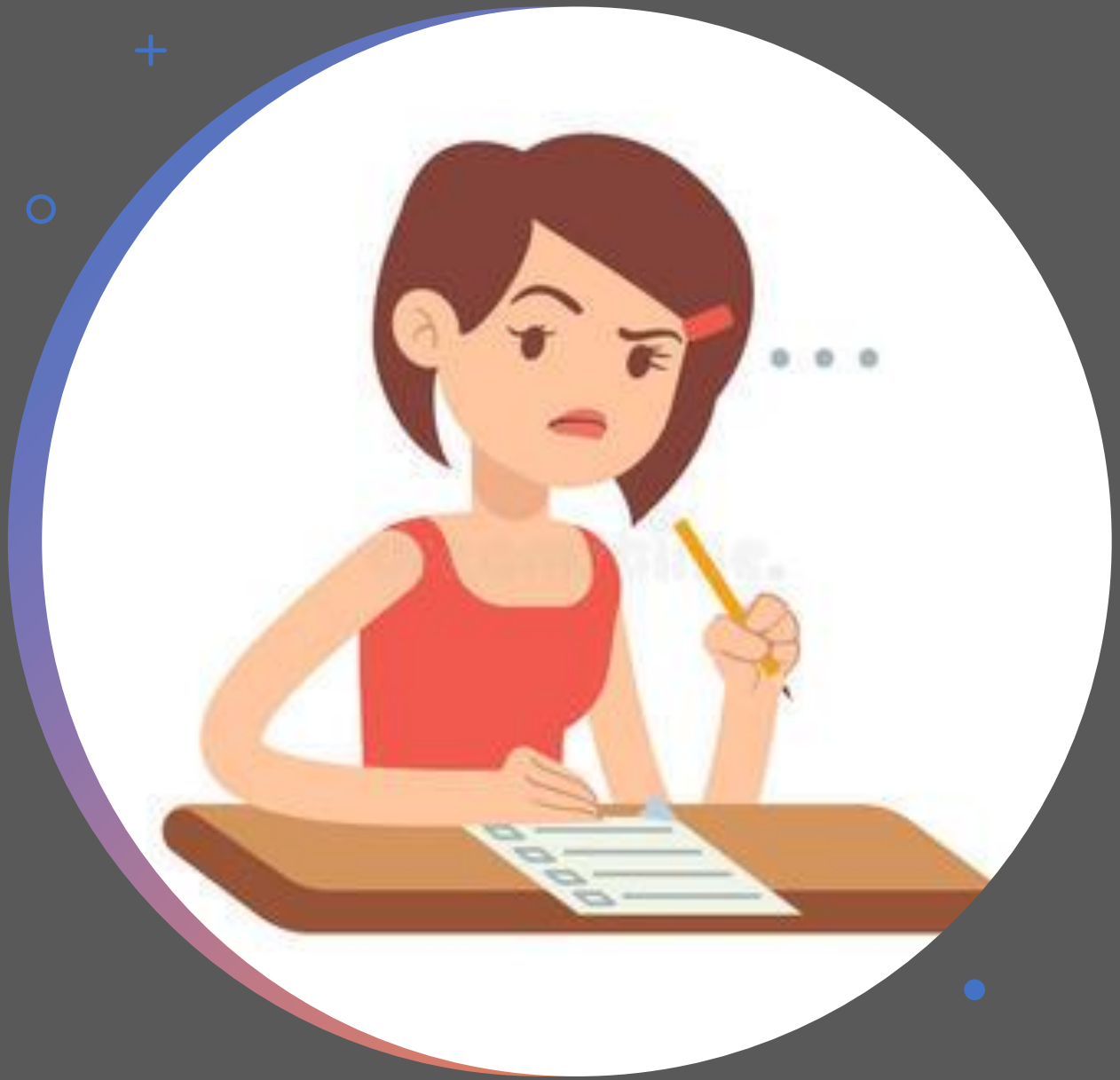

SCAT6 / Child SCAT6

- Orientation
- Immediate Memory
- Concentration
- mBESS
- Delayed Recall

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Visual and Vestibular Symptoms

- Diplopia
- Convergence Insufficiency
- Vestibular Ocular Dysfunction
  - VOMS
    - **Smooth Pursuit**
    - **Saccades Horizontal & Vertical**
    - **Convergence**
    - **VOR Horizontal &VOR Vertical**
    - **Visual Motion Sensitivity**

Much of the time resolve spontaneously in acute concussion

However, consider referral for symptoms not resolving in the first few weeks

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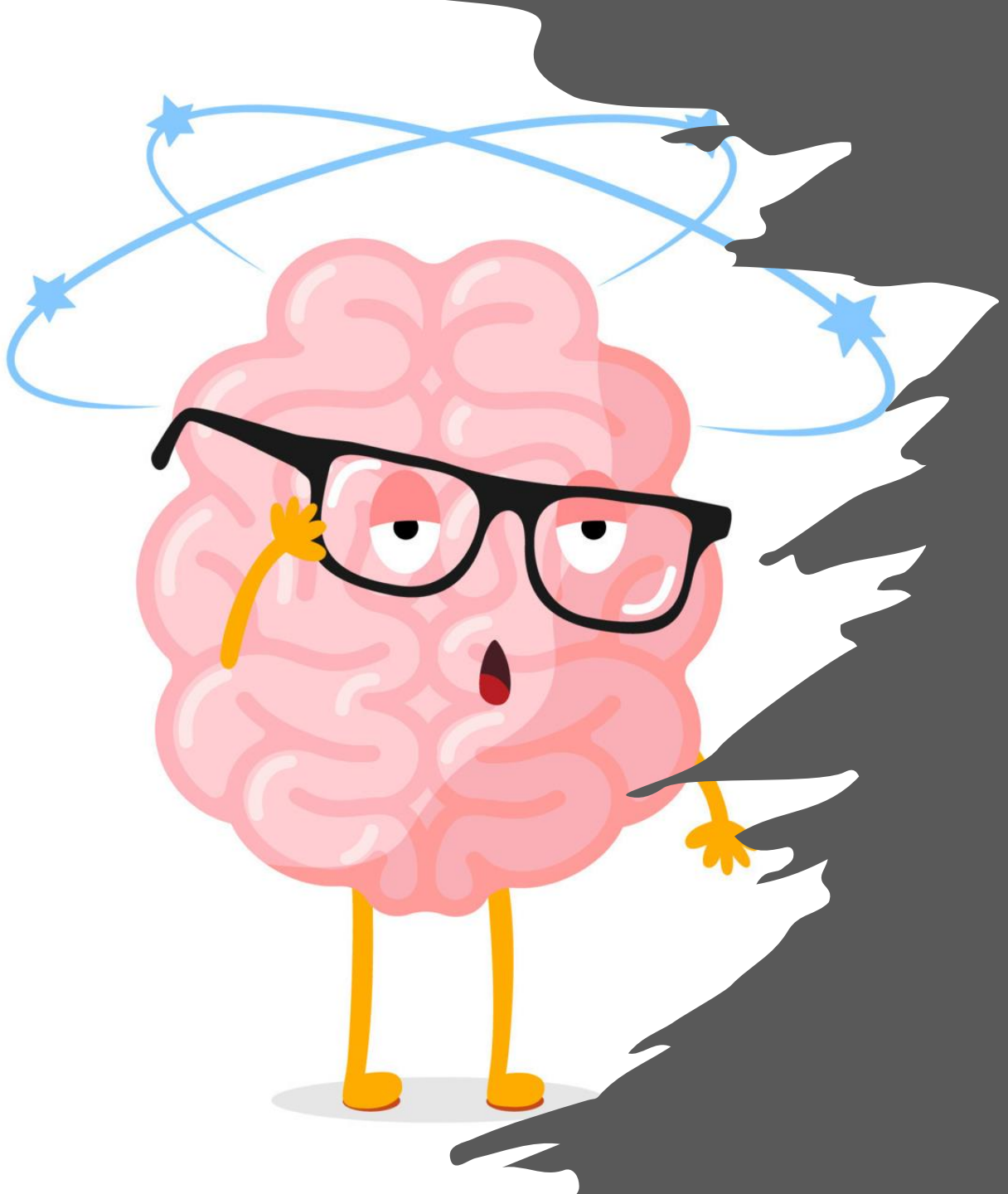

VestibularOccularDysfunction

- The way the inner ears, brain, and eyes work together to detect motion, and head position in space
- Needed for balance, stable vision, and to track a target
- Increased prevalence after concussion in kids
  - 28-60% depending on the study
- Even higher prevalence in patients with post concussion

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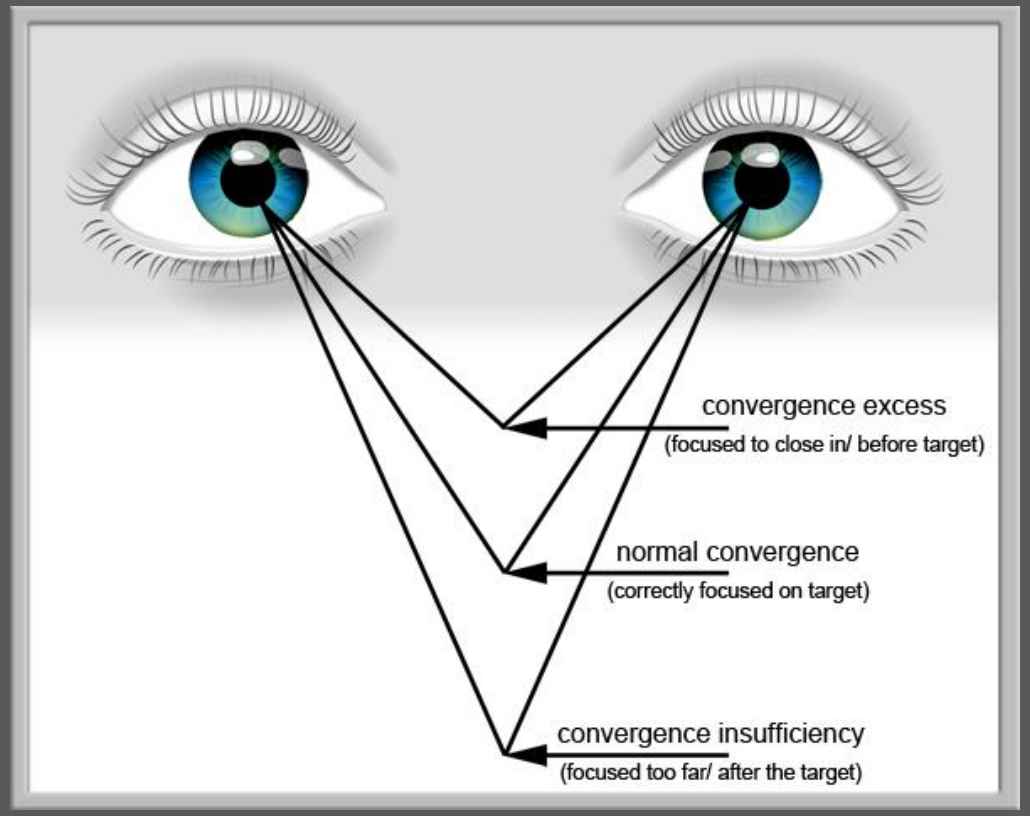
Convergence Insufficiency



Double vision makes it difficult to read and comprehend.

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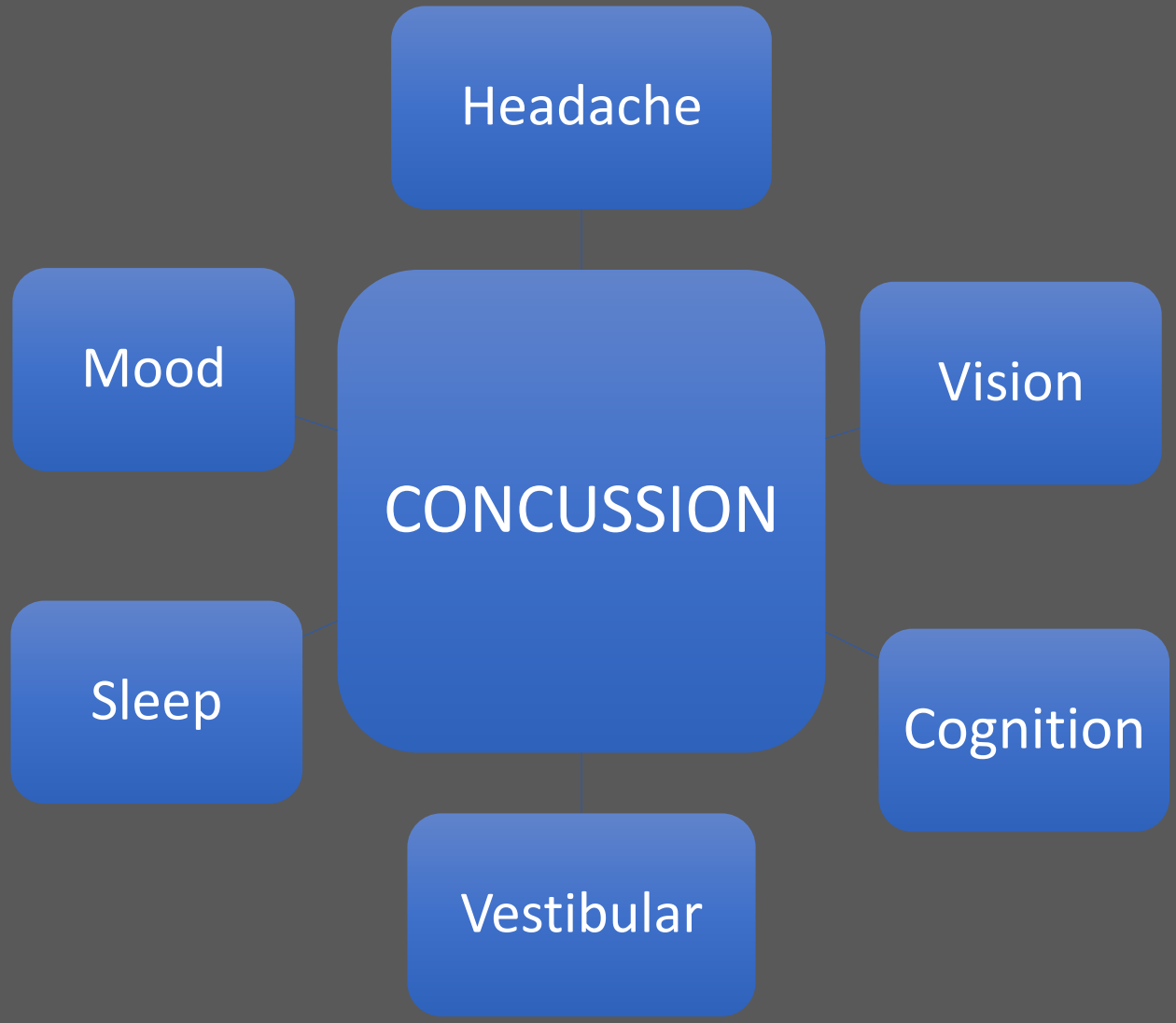
Concussion Clinical Sequalae



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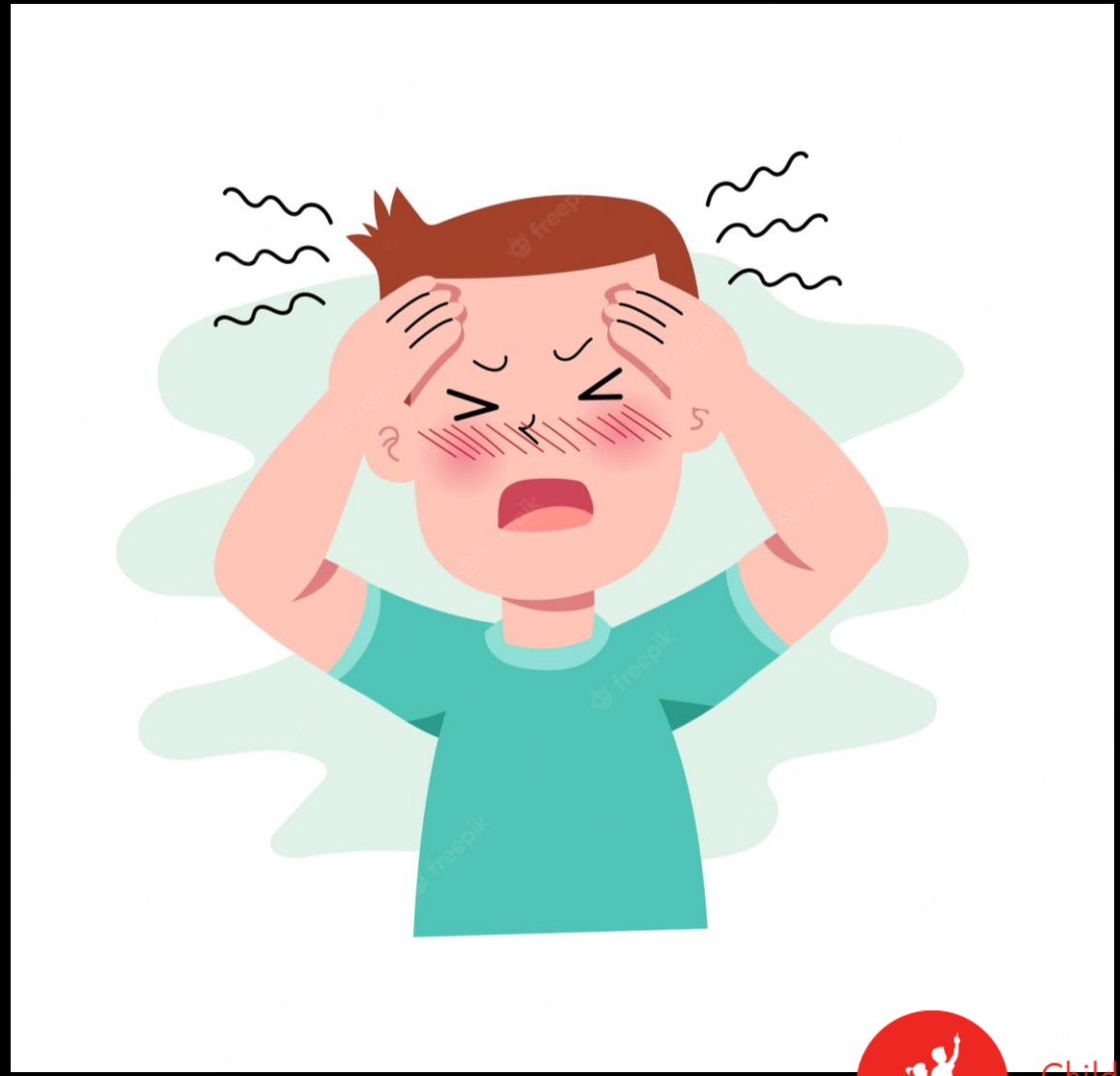
Headaches

- Headache is a very common symptom (migraine, cervicogenic, occipital neuralgia, ocular, etc.)
  - May be accompanied by nausea, light and noise sensitivity, visual symptoms
- Encourage child to take a break/step away from these activities
- Hydration (water and sports drink)
- Medications: Tylenol & Ibuprofen (for a short time)
- Avoiding triggers – bright, loud places



Sleep Hygiene

- Consistent bedtime and waking time
- Same routine every night
- Dark, quiet space
- No screen time (phone, computer, videogame, tablet) 1 hour prior to bed
- +/- Melatonin*

Emotional

- Irritability/ Anger
- Emotional liability/ More clingy
- Sadness/Depression/ More withdrawn
- Anxiety

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Cognitive Symptoms

- Mental Fogginess
- Difficulty Concentrating/Focusing (ADHD)
- Memory problems, especially short term
- Slow processing speed
- Executive functioning issues (trouble managing thoughts, emotions, and actions)

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Cognitive Accommodations

- Gradual return to school (Time <u>AND</u> Task based)
  - ½ day passive learning
  - Full day passive learning
  - ½ day passive, ½ day active learning
  - Full day active learning
- Time Based vs Task Based
- Individualized Based on the needs of each child

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School Accommodations to Consider

- Shortened day (1/2 day, 2-3 classes)
- Rest breaks as needed for concussion symptoms
- Using printed class notes of a peer or teacher
- Avoiding gymnasium, hallways, cafeteria
- Water bottle in class

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School Accommodations continued…

- Sunglasses/ hats
- Dimming/Limiting Screens (blue light glasses)
- Gradually adding in pertinent homework and tests
- Extra time for homework and tests
- No standardized testing (STAR, ACT, etc.)
- Making up only essential assignments

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Return to Play Criteria

- Symptom Free
- Normal Exam
  - Including eye tracking, vestibular, balance and coordination
- Returned to full academics and baseline academic achievement
- Off medications that could be covering up symptoms

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Return to Play

Rehabilitation stage	Functional exercise at each stage of rehabilitation	Objective of each stage
No activity	Physical and cognitive rest	Recovery
Light aerobic exercise	Walking, swimming or stationary cycling keeping intensity, 70 % maximum predicted heart rate. No resistance training	Increase heart rate
Sport-specific exercise	Skating drills in ice hockey, running drills in soccer. No head impact activities	Add movement
Non-contact training drills	Progression to more complex training drills, eg passing drills in football and ice hockey. May start progressive resistance training	Exercise, coordination, and cognitive load
Full contact practice	Following medical clearance participate in normal training activities	Restore confidence and assess functional skills by coaching staff
Return to play	Normal game play	

Tools:

- Sport Concussion Assessment Tool 6 (SCAT6) (bmj.com)
- Child SCAT6 (bmj.com)
- Acute Concussion Evaluation (cdc.gov)
- The Concussion Recognition Tool 6 (CRT6) (bmj.com)
- VOMS (memberclicks.net)

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Questions??

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