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Concussion Management for the Primary Care Pediatrician

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Disclosures

- None

Objectives

1. Define sport-related concussion (SRC)
2. Review the epidemiology and pathophysiology of sport-related concussion
3. Identify signs or symptoms of non-concussion injuries
4. Develop a workflow for in-office evaluation, management, and return to play considerations for concussed athletes
5. Apply recent evidence-based therapies in concussion treatment and recovery

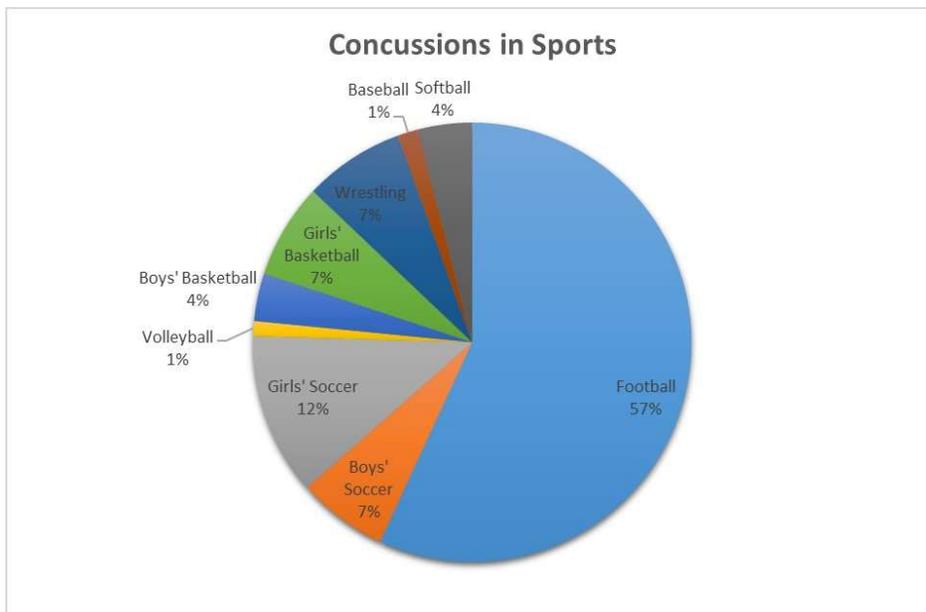
Background

Definition

- **Sport related concussion is a traumatic brain injury induced by biomechanical forces.** Features may include:
 - A direct blow with an impulsive force transmitted to the head.
 - Rapid onset of short-lived impairment of neurological function that resolves spontaneously.
 - No abnormality is seen on standard structural neuroimaging studies.
 - May or may not involve loss of consciousness.



Epidemiology

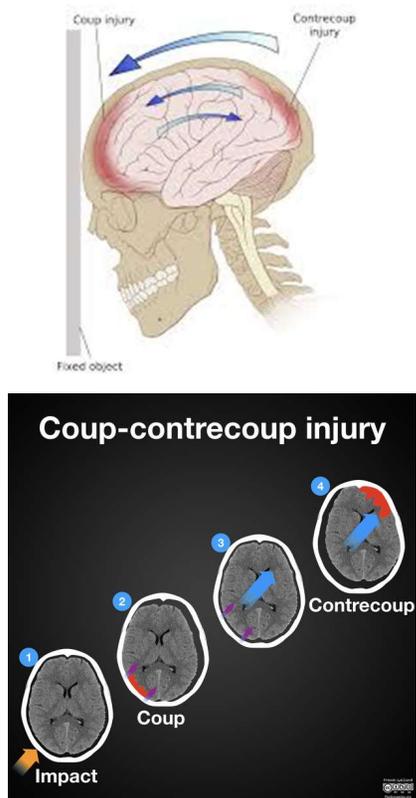


- Between 1-2 million pediatric sports-related concussions annually in the U.S.
- Males > Females
- Gender-comparable sports: females greater than males
- Top male sports:
 - Tackle football
 - Lacrosse
 - Ice hockey
- Top female sports:
 - Soccer
 - Lacrosse
 - Field hockey

Where Patients Get Care

- Exact data unclear due to underreporting of symptoms
- **At home, self-directed** (i.e. do not seek medical care)
 - Up to 45-65% of SRC patients
- Emergency department
 - Estimated 500,000-1,000,000 visits annually
 - Increasing numbers year-to-year
- **PCP office**
 - Up to 75% of SRC patients
- Specialist office (neurology, sports medicine, PM&R)

Pathophysiology



- Direct impact
or
- Coup-Contrecoup mechanism
 - Coup
 - Impact at skull
 - Brain adjacent to skull forcibly impinged
 - Focal damage
 - Contrecoup
 - Due to impact, intracranial contents travel in direction of skull
 - Skull stops
 - Brain impacts skull

Pathophysiology

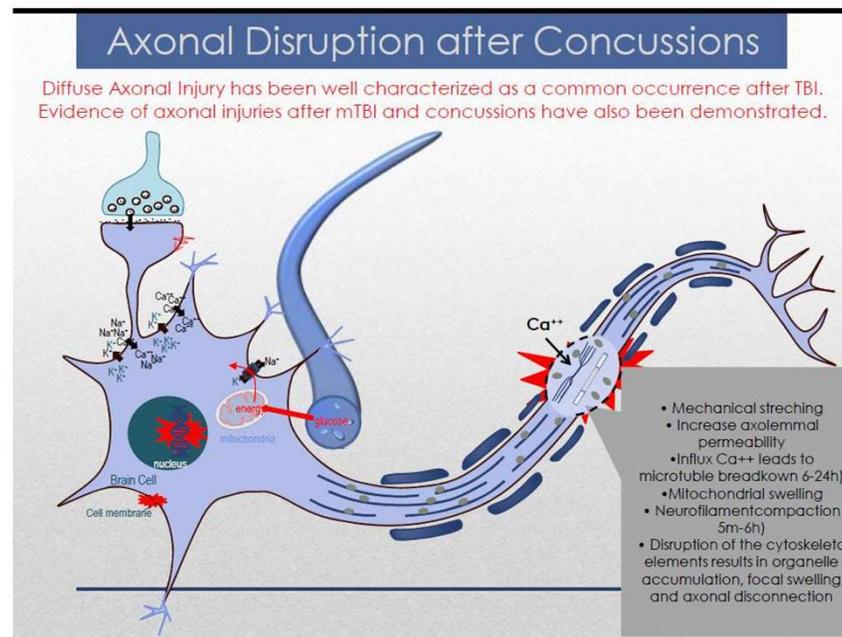
- Shearing and stretching forces → Diffuse neuronal depolarization → Immediate post-injury symptoms
 - Excitatory neurotransmitter release (acetylcholine, glutamate, aspartate)
 - Increased GLUT-to-GABA ratio at 2 weeks

Table 1 Acute neurometabolic changes following mTBI

	Post-injury change	Mechanism	Pathophysiologic effect	Recovery timeline
Glutamate	Immediate release from injured neurons followed by region-specific decrease	“Mechanoporation” produces neuronal depolarization and neurotransmitter release	Promotes feedback loop of depolarization and neuron hyperexcitability Promotes influx of sodium and calcium	Initial increase normalizes within minutes of injury Region-specific decrease at 72 h recovers by 2 weeks post-injury
Gamma-aminobutyric-acid (GABA)	Decreased in a region-specific and time-dependant manner	Loss of GABA-ergic interneurons has been suggested [14]	Decreased neuronal inhibitory effect	Region-specific decrease up to 2 weeks
Potassium	Extraneuronal increase	Glutamate stimulates potassium efflux via ligand-gated potassium channels	Stimulation of feedback loop of depolarization and hyperexcitability	Within 10 min from injury
Calcium	Intraneuronal increase/accumulation	Initial neuronal “mechanoporation” Promoted by glutamate release	Cell damage and mitochondrial impairment	Approximately 3 to 4 days after injury
Glucose	Increase followed by decrease	Increased neuronal glycolysis followed by hypometabolism + blood flow-uncoupling	Decreased ATP from deficient oxidative metabolism Ineffective anaerobic metabolism	Hyperglycolytic phase: • 30 min to 6 h Hypometabolic phase: • 5 to 10 days
Blood flow	Global as well as regional and time-dependant decreases	Autoregulatory and vasoreactive disturbances induced by CO ₂ Local and diffuse structural vessel damage	Promotes anaerobic metabolism “Window of vulnerability” to repeated head impacts	Approximately 10 days

Pathophysiology

- Microstructural axonal damage
- Neurofilament and microtubule deformation → Mechanical axonal injury → Disrupted axonal transport, Accumulation of beta-amyloid precursor protein



Making the Diagnosis

HPI

- More commonly during **competition play**
- Mechanism: Injury to head, neck, face, or body with transmission to head
- Confusion
- **May or may not** have loss of consciousness
- May have **immediate short-term amnesia** in the peri-impact time frame
- “Seeing stars”, “got my bell rung”



Acute Evaluation

- At the time of injury
- Focused history
 - “Who is your opponent? What is the quarter? What is the score?”
 - “Do you remember the injury?”
 - Current symptoms
- Focused physical exam
 - Neuro
 - Cervical spine

What venue are we at today?	Y	N
Which half is it now?	Y	N
Who scored last in this match?	Y	N
What team did you play last week / game?	Y	N
Did your team win the last game?	Y	N



Red Flags

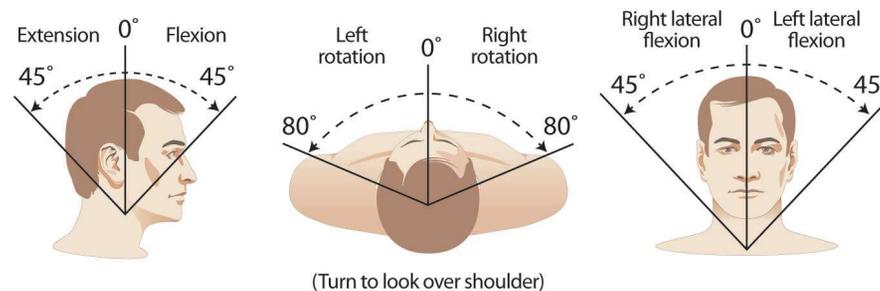
- High-risk mechanism
- High-risk medical history/medical problems
- Fluctuating/deteriorating consciousness, prolonged LOC, prolonged confusion
- Skull fractures, penetrating skull injury
- Persistent vomiting
- Focal neurologic findings
- Seizure or seizure-like movements
- Cervical spine pain or tenderness
- Double vision
- Severe or increasing headache
- Increasingly restless, agitated or combative



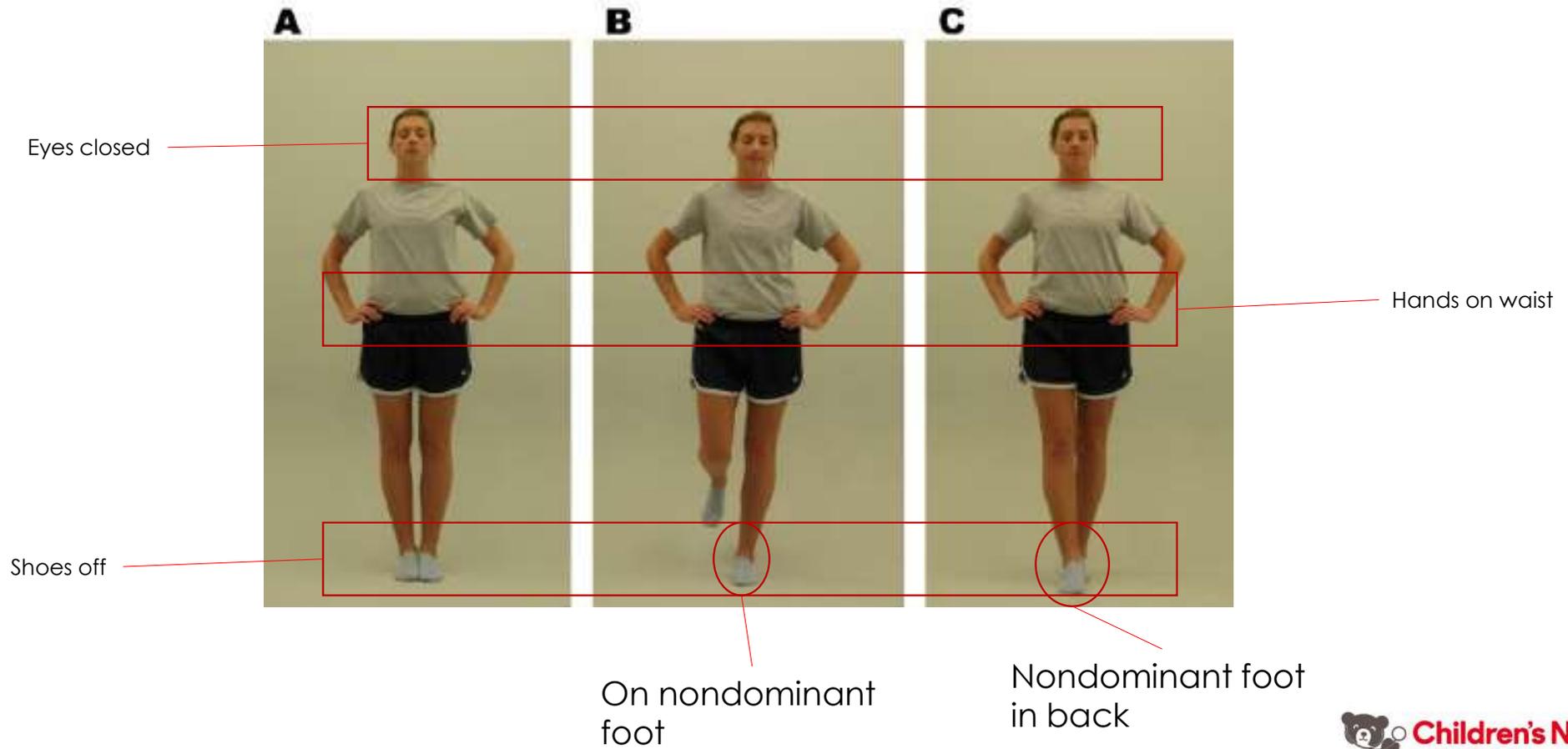
Physical Exam

- Cranial nerve exam
- Cervical exam
 - Neck ROM (flexion/extension, lateral bends, and rotation)
 - Palpation over midline and paraspinal musculature
- General neuro exam
- Cerebellar testing: FNF, HTS, rapid alternating movements

Figure 1: Cervical spine range of motion



Modified Balance Error Scoring System (mBESS)



VOMS: Vestibular-Ocular Motor Screening

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 tip 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

Management

Management: Acute



- If diagnosed/suspected at a sporting event:
- **When in doubt, keep them out.**
- Symptom increase over 24-48 hours
 - 24-48 hours cognitive rest
 - Complete physical rest until reevaluated

Management: Pharmacotherapy

- Initial 48 hours
 - Avoid NSAIDs, aspirin
 - Minimize acetaminophen
- Duration of concussion
 - Use acetaminophen, NSAIDs sparingly
 - Need to be off medications to return to sports
 - Do not use prophylactically
- Resume preexisting headache medications

“If you didn’t have a concussion, would you take medicine for this headache?”



Additional Testing



- CT
 - Acute evaluation for ICH and skull fracture
- MRI
 - No role for acute or prolonged post-concussive symptoms
 - Klein et al: 1 out of 138 prospective sports-related concussion athletes had an acute, injury-related finding
 - High rate of nonspecific MRI changes
- Lab testing
 - No evidence for lab testing

SCAT-5 Post-Concussive Symptom Sheet

- Filled out at every visit
 - “Fill out how you feel **right now**”
- Symptom underreporting common, so do not trust a “0”
 - *Example*: Patient reports 0 symptoms but is not caught up on school and has ongoing objective findings, or parental concern
- Not all patients may reach a “0”
 - *Example*: Patient with baseline insomnia may always report “trouble falling asleep”

	none	mild		moderate		severe		
Headache	0	1	2	3	4	5	6	
“Pressure in head”	0	1	2	3	4	5	6	
Neck Pain	0	1	2	3	4	5	6	
Nausea or vomiting	0	1	2	3	4	5	6	
Dizziness	0	1	2	3	4	5	6	
Blurred vision	0	1	2	3	4	5	6	
Balance problems	0	1	2	3	4	5	6	
Sensitivity to light	0	1	2	3	4	5	6	
Sensitivity to noise	0	1	2	3	4	5	6	
Feeling slowed down	0	1	2	3	4	5	6	
Feeling like “in a fog”	0	1	2	3	4	5	6	
“Don’t feel right”	0	1	2	3	4	5	6	
Difficulty concentrating	0	1	2	3	4	5	6	
Difficulty remembering	0	1	2	3	4	5	6	
Fatigue or low energy	0	1	2	3	4	5	6	
Confusion	0	1	2	3	4	5	6	
Drowsiness	0	1	2	3	4	5	6	
More emotional	0	1	2	3	4	5	6	
Irritability	0	1	2	3	4	5	6	
Sadness	0	1	2	3	4	5	6	
Nervous or Anxious	0	1	2	3	4	5	6	
Trouble falling asleep (if applicable)	0	1	2	3	4	5	6	
Total number of symptoms:							of 22	
Symptom severity score:							of 132	

Management: Initial Visit



- HPI and PE
- Detailed risk factor history:
 - Concussion history, including delayed return to play
 - Learning disorders and IEPs
 - Mental health disorders.
 - Notably depression, anxiety, ADHD
 - Sleep hygiene
 - Screen time
 - Emotional lability
- Assess current symptomatology
- Provide restrictions to school

Management: Follow-Up



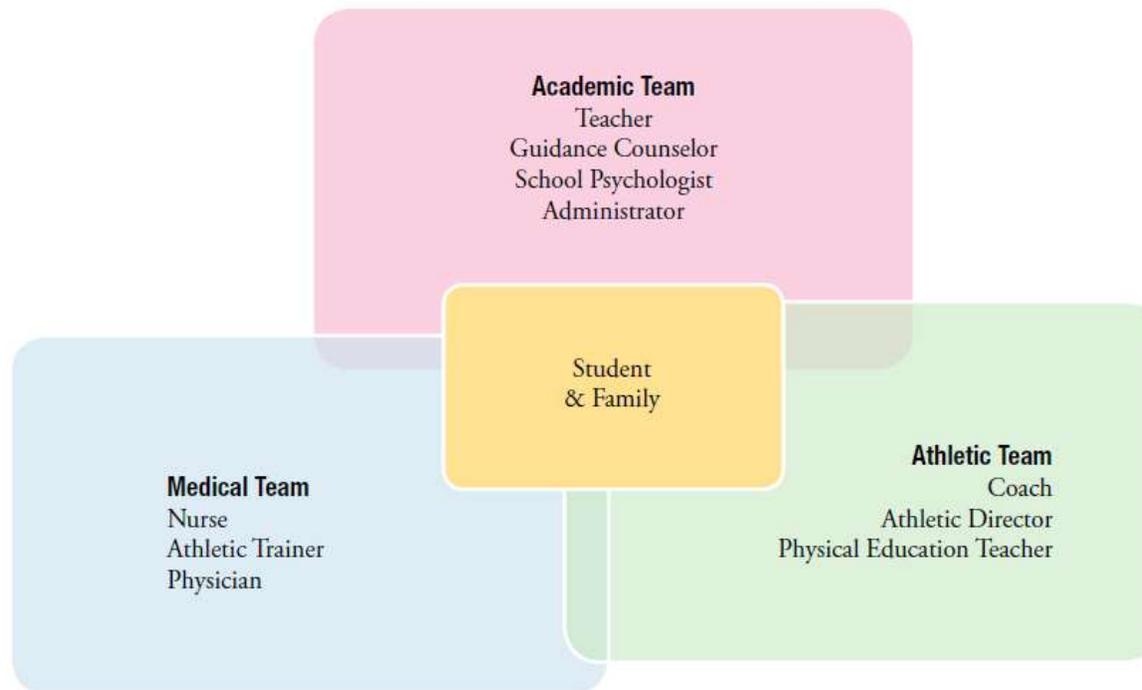
- Post-Concussion Symptom sheet
- Focused exam: BESS, VOMS, and any abnormal findings
- If not improving:
 - **Screen time, screen time, screen time**
 - Consider referral
 - Sports medicine
 - Neurology
 - Neuropsychological testing
 - Physical therapy

The Role of Rest: Sub-Symptomatic Exercise

- Acute phase (first 48 hours): Complete physical rest
- High quality evidence supporting sub-symptomatic exercise
 - Quicker concussion recovery
 - Does not lead to acute exacerbations
- Sample activities:
 - Walk
 - Stationary bike
 - Elliptical
- Avoid:
 - Weight training
 - Activities with head injury risk



A Concussion Treatment Plan



Concussion Return to School Form

SCHOOL LETTER Returning to School After a Concussion



Based on the student's current symptoms, I recommend that the student:

- Be permitted to return to school and activities while school professionals closely monitor the student. School professionals should observe and check in with the student for the first two weeks, and note if symptoms worsen. If symptoms do not worsen during an activity, then this activity is OK for the student. If symptoms worsen, the student should cut back on time spent engaging in that activity, and may need some short-term support at school. Tell the student to update his or her teachers and school counselor if symptoms worsen.
- Is excused from school for _____ days.

The student is currently reporting the following symptoms:



PHYSICAL

- Bothered by light or noise
- Dizziness or balance problems
- Feeling tired, no energy
- Headaches
- Nausea or vomiting
- Vision problems



THINKING OR REMEMBERING

- Attention or concentration problems
- Feeling slowed down
- Foggy or groggy
- Problems with short- or long-term memory
- Trouble thinking clearly



SOCIAL OR EMOTIONAL

- Anxiety or nervousness
- Irritability or easily angered
- Feeling more emotional
- Sadness



SLEEP

- Sleeping less than usual
- Sleeping more than usual
- Trouble falling asleep

Based on the student's symptoms, please make the short-term changes checked below:

- No physical activity during recess
- No physical education (PE) class
- No after school sports
- Shorten school day
- Later school start time
- Reduce the amount of homework
- Postpone classroom tests or standardized testing
- Provide extended time to complete school work, homework, or take tests
- Provide written notes for school lessons and assignments (when possible)
- Allow for a quiet place to take rest breaks throughout the day
- Lessen the amount of screen time for the student, such as on computers, tablets, etc.
- Give ibuprofen or acetaminophen to help with headaches (as needed)
- Allow the student to wear sunglasses, earplugs, or headphones if bothered by light or noise
- Other: _____

Concussion School Accommodations

- Concentrate first on general cognitive skills, such as flexible thinking and organization, rather than academic content.
 - Focus on what the student does well and expand the curriculum to more challenging content as concussion symptoms subside.
 - Adjust the student's schedule as needed to avoid fatigue: shorten day, time most challenging classes with time when student is most alert, allow for rest breaks, reduced course load.
 - Adjust the learning environment to reduce identified distractions or protect the student from irritations such as too-bright light or loud noises.
 - Use self-paced, computer-assisted, or audio learning systems for the student having reading comprehension problems.
- Allow extra time for test/in-class assignment completion. Help the student create a list of tasks and/or daily organizer.
 - Assign a peer to take notes for the student.
 - Allow the student to record classes.
 - Increase repetition in assignments to reinforce learning.
 - Break assignments down into smaller chunks and offer recognition cues.
 - Provide alternate methods for the student to demonstrate mastery, such as multiple-choice or allowing for spoken responses to questions rather than long essay responses.

Academics and Concussion Return

- No formal guidelines
- My rules of thumb:
 - Full school days without extra accommodations
 - Asymptomatic with schoolwork and homework
 - Caught up or a clear plan to catch up on exams, projects

Return to Play

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.	

Contact

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