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Management of Concussion and Postconcussion Syndrome

What is it?
How do you treat it?
When do you refer?

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No disclosures

Objectives

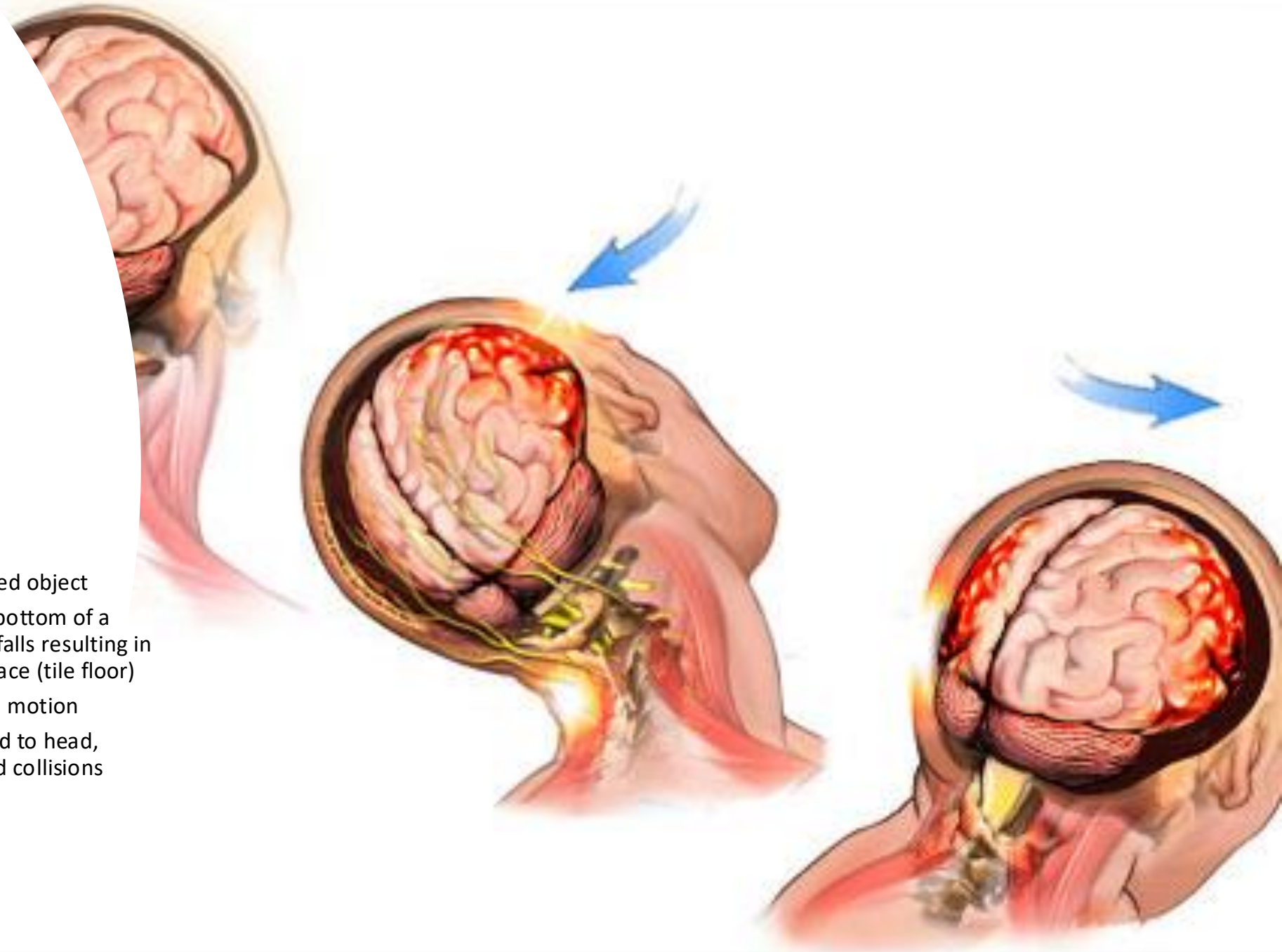
- Define - Concussion/mTBI
- Review and differentiate symptoms of concussion vs PCS
- Discuss the incidence of concussion and who is at risk for PCS
- Review imaging recommendations for concussion
- Discuss management/treatment for concussion and PCS
- Discuss when to refer to concussion specialist

What is a Concussion?

- A mild traumatic brain injury (mTBI)
- Head injury due to contact and/or acceleration-deceleration and rotational forces
- GCS 13 to 15
- "…a clinical syndrome of biomechanically induced alteration of brain function, typically affecting memory and orientation, which may (or may not) involve loss of consciousness." *AAN*

What Causes a Concussion?

- Falls or tackles
- Acceleration/Deceleration
  - MVA
  - Shaken
  - Roller coasters
- Direct Hit to the head by an object
  - Striking of the head against any fixed object
    - Walking into a door frame, bottom of a locker, granite counter top, falls resulting in the head hitting a fixed surface (tile floor)
  - Striking of the head by an object in motion
    - Balls, bats, toys, blocks, head to head, elbow to head, knee to head collisions



Typical Signs and Symptoms of Concussion

- Headache
- Vision disturbances
- Dizziness
- Nausea or vomiting
- Impaired balance
- Ringing ears
- Confusion
- Memory loss
- Perseverating
- Difficulty concentrating
- Sensitivity to light
- Seizure (not common)

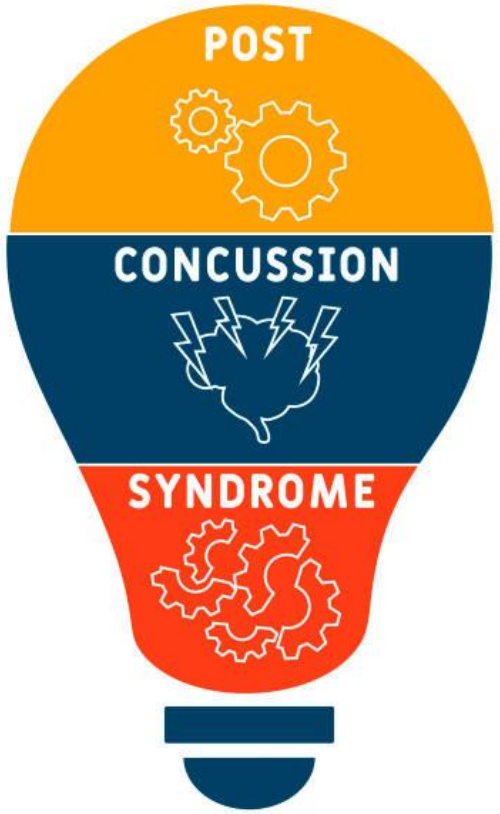
Postconcussion Syndrome (PCS)

Common sequelae of traumatic brain injury (TBI), complex of symptoms that includes headache, dizziness, neuropsychiatric symptoms, sleep issues, and cognitive impairment

Most common after mTBI (30-80%), but can also occur after moderate or severe TBI

As most concussion symptoms last 7-14 days, ICD-10 defines PCS as symptoms occurring > 3 weeks

Symptoms of
Post Concussion Syndrome



Physical

- Headache
- Dizziness
- Fatigue
- Imbalance
- Sleep disturbance/ insomnia
- Light or sound sensitivity
- Visual disturbance
- Nausea

Cognitive

- Loss of concentration
- Memory problems
- Difficulty understanding, finding words, reading

Behavioral

- Irritability
- Anxiety
- Depression

JAMA Pediatrics | Special Communication

Centers for Disease Control and Prevention Guideline on the Diagnosis and Management of Mild Traumatic Brain Injury Among Children

Angela Lumba-Brown, MD; Keith Owen Yeates, PhD; Kelly Sarmiento, MPH; Matthew J. Breiding, PhD; Tamara M. Haegerich, PhD; Gerard A. Gioia, PhD; Michael Turner, MD; Edward C. Benzel, MD; Stacy J. Suskauer, MD; Christopher C. Giza, MD; Madeline Joseph, MD; Catherine Broomand, PhD; Barbara Weissman, MD; Wayne Gordon, PhD; David W. Wright, MD; Rosemarie Scolaro Moser, PhD; Karen McAvoy, PhD; Linda Ewing-Cobbs, PhD; Ann-Christine Duhaime, MD; Margot Putukian, MD; Barbara Holshouser, PhD; David Paulk, EdD; Shari L. Wade, PhD; Stanley A. Herring, MD; Mark Halstead, MD; Heather T. Keenan, MD, PhD; Meeryo Choe, MD; Cindy W. Christian, MD; Kevin Guskiewicz, PhD, ATC; P. B. Raksin, MD; Andrew Gregory, MD; Anne Mucha, PT, DPT; H. Gerry Taylor, PhD; James M. Callahan, MD; John DeWitt, PT, DPT, ATC; Michael W. Collins, PhD; Michael W. Kirkwood, PhD; John Ragheb, MD; Richard G. Ellenbogen, MD; Theodore J. Spinks, MD; Theodore G. Ganiats, MD; Linda J. Sabelhaus, MLS; Katrina Altenhofen, MPH; Rosanne Hoffman, MPH; Tom Getchius, BA; Gary Gronseth, MD; Zoe Donnell, MA; Robert E. O'Connor, MD, MPH; Shelly D. Timmons, MD, PhD

IMPORTANCE Mild traumatic brain injury (mTBI), or concussion, in children is a rapidly growing public health concern because epidemiologic data indicate a marked increase in the number of emergency department visits for mTBI over the past decade. However, no evidence-based clinical guidelines have been developed to date for diagnosing and managing pediatric mTBI in the United States.

+ Editorial
+ Related article
+ Supplemental content

Diagnosis

- *Recommendation 1A:* Health care professionals should **not routinely obtain head computed tomography (CT) for diagnostic purposes** in children with mTBI (moderate; level B).
- *Recommendation 1B:* Health care professionals should **use validated clinical decision rules to identify** children with mTBI at low risk for ICI (intracranial injury) in whom head CT is not indicated, as well as **children who may be at higher risk for clinically important ICI** and thus may warrant head CT:

    Age younger than 2 years, vomiting, loss of consciousness, severe mechanism of injury, severe or worsening headache, amnesia, nonfrontal scalp hematoma, Glasgow Coma Scale score less than 15, clinical suspicion for skull fracture (moderate; level B).

- *Recommendation 1C*: For children diagnosed as having mTBI, health care professionals should **discuss the risks of pediatric head CT in the context of risk factors for ICI** with the patient and his/her family (moderate; level B).

    Up to 7.5% of children in the ED with mTBI will have ICI

    Head CT is the preferred diagnostic tool in acute care settings to rapidly identify ICI. However, higher doses of radiation attributable to this type of imaging in children have been associated in studies

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Original Article

Prevalence of Abnormal Magnetic Resonance Imaging Findings in Children with Persistent Symptoms after Pediatric Sports-Related Concussion

Robert H. Bonow,[1,2] Seth D. Friedman,[3] Francisco A. Perez,[4] Richard G. Ellenbogen,[2] Samuel R. Browd,[2] Christine L. Mac Donald,[2] Monica S. Vavilala,[1,5] and Frederick P. Rivara[1,6]

- Retrospective study
- 3338 children with concussion
- 427 underwent MRI 14 or more days post injury (median 32 days)
- 2 patients (0.5%) had abnormal MRIs related to traumatic injury, showing microhemorrhages (SWI)
- Both patients had history of 3 prior concussions
- 61 patients (14.3%) had abnormal findings unrelated to trauma (nonspecific T2 lesions, Chiari I malformation, pineal cysts, arachnoid cysts)

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Prognosis

- *Recommendation 7A*: Health care professionals **should counsel patients and families that most (70%-80%) children with mTBI do not show significant difficulties that last more than 1 to 3 months** after injury (moderate; level B).
- *Recommendation 7B*: Health care professionals should counsel patients and families that, although some factors predict an increased or decreased risk for prolonged symptoms, **each child's recovery from mTBI is unique and will follow its own trajectory** (moderate; level B).
- *Recommendation 8B*: Health care professionals should counsel children and families completing preparticipation athletic examinations and children with mTBI, as well as their families, that **recovery from mTBI might be delayed in those with the following**:

  Premorbid histories of mTBI, lower cognitive ability/ learning difficulties, neurological or psychiatric disorder, increased preinjury symptoms (ie, similar to those commonly referred to as "postconcussive"), family and social stressors (moderate; level B).

  Symptoms may last longer among older children and adolescents, children of Hispanic race/ethnicity, children of lower SES, children with more severe presentations of mTBI (including those associated with ICI), and children reporting more acute postconcussion symptoms.

Prognosis

- *Recommendation 11B*: For children with mTBI whose symptoms **do not resolve as expected with standard care (ie, within 4-6 weeks),** health care professionals should **provide or refer for appropriate assessments and/or interventions** (moderate; level B).

Management/Treatment

- *Recommendation 12*: In providing **education and reassurance to the family**, the health care professional should include the following information:

  > Warning signs of more serious injury, description of injury and expected course of symptoms and recovery, instructions on how to monitor postconcussive symptoms, prevention of further injury, management of cognitive and physical activity/rest, instructions regarding return to play/recreation and school, clear clinician follow-up instructions (high; level A).

- *Recommendation 13A*: Health care professionals should counsel patients to **observe more restrictive physical and cognitive activity during the first several days after mTBI in children** (moderate; level B).
- *Recommendation 13B*: Following these first several days, health care professionals should counsel patients and families to **resume a gradual schedule of activity that does not exacerbate symptoms, with close monitoring of symptom expression (number and severity)** (moderate; level B).

Management/Treatment

Recommendation 13C: After the successful resumption of a gradual schedule of activity (see recommendation 13B), health care professionals should **offer an active rehabilitation program of progressive reintroduction of noncontact aerobic activity that does not exacerbate symptoms,** with close monitoring of symptom expression (number and severity) (high; level B).

Recommendation 13D: Health care professionals should counsel patients to **return to full activity when they return to premorbid performance if they have remained symptom free at rest and with increasing levels of physical exertion** (moderate; level B).

Table 2

Return-to-sport (RTS) strategy—each step typically takes a minimum of 24 hours

Step	Exercise strategy	Activity at each step	Goal
1	Symptom-limited activity	Daily activities that do not exacerbate symptoms (eg, walking).	Gradual reintroduction of work/school
2	Aerobic exercise **2A—Light** (up to approximately 55% maxHR) **then** **2B—Moderate** (up to approximately 70% maxHR)	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 training involves any risk of inadvertent head impact, medical clearance should occur prior to Step 3	Sport-specific training away from the team environment (eg, 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 the 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 (eg, passing drills, multiplayer training) can integrate into a 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.	

- ***Mild and brief exacerbation of symptoms (ie, an increase of no more than 2 points on a 0–10 point scale for less than an hour when compared with the baseline value reported prior to physical activity). Athletes may begin Step 1 (ie, symptom-limited activity) within 24 hours of injury, with progression through each subsequent step typically taking a minimum of 24 hours. If more than mild exacerbation of symptoms (ie, more than 2 points on a 0–10 scale) occurs during Steps 1–3, the athlete should stop and attempt to exercise the next day. Athletes experiencing concussion-related symptoms during Steps 4–6 should return to Step 3 to establish full resolution of symptoms with exertion before engaging in at-risk activities. Written determination of readiness to RTS should be provided by an HCP before unrestricted RTS as directed by local laws and/or sporting regulations.**
- **HCP, healthcare professional; maxHR, predicted maximal heart rate according to age (ie, 220-age).**

Management/Treatment

Psychosocial/Emotional Support

- *Recommendation 14*: Health care professionals may **assess the extent and types of social support (ie, emotional, informational, instrumental, and appraisal)** available to children with mTBI and emphasize social support as a key element in the education of caregivers and educators (moderate; level C).

Management/Treatment

Return to School

- *Recommendation 15A*: To assist children returning to school after mTBI, medical and school-based teams should **counsel the student and family regarding the process of gradually increasing the duration and intensity of academic activities as tolerated, with the goal of increasing participation without significantly exacerbating symptoms** (moderate; level B).
- *Recommendation 15B*: **Return-to-school protocols should be customized** based on the severity of postconcussion symptoms in children with mTBI as determined **jointly by medical and school-based teams** (moderate; level B).
- *Recommendation 15C*: For any student with **prolonged symptoms** that interfere with academic performance, school-based teams **should assess the educational needs of that student and determine the student's need for additional educational supports**, including those described under pertinent federal statutes (eg, Individuals With Disabilities Education Act §504) (high; level B).

  Medical 504 plan or Individualized Education Plan (IEP)
- *Recommendation 15D*: Postconcussion symptoms and academic progress in school should be **monitored collaboratively by the student, family, health care professional(s), and school teams**, who jointly determine what modifications or accommodations are needed to maintain an academic workload without significantly exacerbating symptoms (high; level B).

Management/Treatment

Return to School

Academic adjustments:

- Shortened school days
- Reduced assignments/homework
- Additional time to complete assignments/homework
- No timed tests
- Open note tests
- Test in a quiet room with no distractions
- Frequent breaks (especially with screen time)
- Go to the nurse for medication and rest
- No or limited physical activity- including PE and recess

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.

Management/Treatment

Return to School

- *Recommendation 15E*: The provision of **educational supports should be monitored and adjusted on an ongoing basis** by the school-based team until the student's academic performance has returned to preinjury levels (moderate; level B).
- *Recommendation 15F*: For students who demonstrate **prolonged symptoms and academic difficulties** despite an active treatment approach, health care professionals should **refer the child for a formal evaluation by a specialist** in pediatric mTBI (moderate; level B).

Post-traumatic headache (PTH)

- Headache is the most common symptom after a concussion, occurring in over 90% of athletes with sports-related concussions
- PTH have no defining features, they are classified according to headache type
- Migraine > tension-type headaches – seen in up to 55% of children
- Pre-existing headaches are associated with an increased incidence and severity of headaches after head trauma
    - Other risk factors: female gender, adolescent, prior concussion, co-existing disorders such as anxiety, depression, poor coping, and family history of migraine

Management/Treatment

Posttraumatic Headache

- *Recommendation 16C*: Health care professionals and caregivers should offer **nonopioid analgesia (ie, ibuprofen or acetaminophen)** to children with painful headache after acute mTBI but also **provide counseling to the family regarding the risks of analgesic overuse, including rebound headache** (moderate; level B).
- *Recommendation 16E*: **Chronic headache after mTBI is likely to be multifactorial**; therefore, health care professionals should **refer children with chronic headache after mTBI for multidisciplinary evaluation and treatment**, with consideration of analgesic overuse as a contributory factor (high; level B).

PTH Treatment

- Avoid triggers (gradual return to school/activity, breaks as needed)
- Start “subsymptom, submaximal non-contact exercise/activity” after ~48 hours of rest post-injury
- Lifestyle management: hydration, sleep, eating, stress, caffeine
- Abortive medications: acetaminophen*, ibuprofen*, long-acting NSAIDS (naproxen), triptans; do not use narcotics or butalbital-containing medications
  - Naproxen “bridge” – 10 mg/kg/dose BID for 1 week
  - Small case report showed benefit with oral steroids*
  - Watch for medication overuse
- Treat nausea with antiemetics (ondansetron, prochlorperazine, promethazine, metoclopramide)
- If headaches persist, consider starting prophylaxis
  - Cyproheptadine in younger children, anti-epileptic medications: topiramate*, gabapentin, valproate, beta-blockers: propranolol*, tricyclic antidepressants*: amitriptyline, nortriptyline
  - Vitamin supplements: vitamin B2*, magnesium*, coenzyme Q10, feverfew, melatonin*
  - Alternative treatments: CBT*, biofeedback*, acupuncture*, PT*, migraine devices
  - Onabotulinumtoxin A
- Status migraine
  - ER or hospital admission for IV medications*
  - Nerve block injections*
  - Sphenopalatine ganglion block

*limited evidence for pediatric PTH

Management/Treatment

Dizziness or imbalance (lightheadedness, vertigo)

Increased water +/- sodium

Low dose beta blocker

Physical therapy or vestibular therapy (also PT)

Visual symptoms (accommodative disorders, convergence insufficiency, saccadic dysfunction)

Occupational therapy

Neuro-optometry, vision therapy

Recommendation 17: Health care professionals **may refer children with subjective or objective evidence of persistent vestibulo-oculomotor dysfunction** after mTBI to a program of **vestibular rehabilitation** (moderate; level C).

Management/Treatment

Sleep

- *Recommendation 18A*: Health care professionals should **provide guidance on proper sleep hygiene methods** to facilitate recovery from pediatric mTBI (moderate; level B).

Sleep at least 8 hours per night	may need sleep aides (low dose melatonin)
Good sleep habits	Don't alter sleep patterns at night
Frequent rest during the day while symptoms are present (avoid late afternoon sleep)	

- *Recommendation 18B*: If **sleep problems emerge or continue** despite appropriate sleep hygiene measures, health care professionals may **refer children with mTBI to a sleep disorder specialist** for further assessment (moderate; level C).

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Management/Treatment

Cognitive Impairment

- *Recommendation 19A*: Health care professionals should attempt to **determine the etiology of cognitive dysfunction** within the context of other mTBI symptoms (moderate; level B).
- *Recommendation 19B*: Health care professionals should **recommend treatment for cognitive dysfunction** that reflects its presumed etiology (high; level B).
- *Recommendation 19C*: Health care professionals may **refer children with persisting problems related to cognitive function for a formal neuropsychological evaluation** to assist in determining the etiology and recommending targeted treatment (high; level C).

    Cognitive impairment can include attention, memory and learning, response speed, and executive functions.

    May be directly related to the pathology of the brain injury (ie, impaired neurotransmission) but may also reflect secondary effects of other symptoms (ie headache pain, fatigue/low energy, depression)

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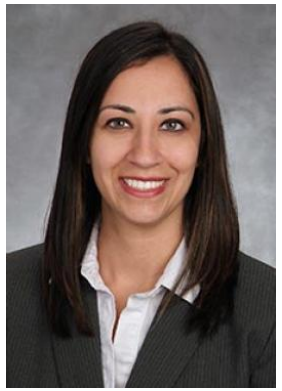
Neurology

Non-sports related concussion



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Neurosurgery

Non-sports related concussion, skull fractures, brain hemorrhage

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Sports Medicine

Sports related concussion

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Neuropsychology

Cognitive postconcussion symptoms

Aimee Hammer, PhD

Laura Winstone-Weide, PhD

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Phoenix Children's Concussion Program

Multidisciplinary rehabilitation team:

- Physical therapy
- Occupational therapy
- Speech therapy

Other:

- Headache Program
- Sleep Disorders Program

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Resources

CDC- Heads Up: Concussion
https://www.cdc.gov/headsup/index.html

Barrow Concussion Network
http://www.thebarrow.org/Neurological_Services/Concussion_Center/234182

AAN Sports Concussion Toolkit https://www.aan.com/practice/sports-concussion-toolkit

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THE WOODPECKERS ARE JUST SITTING THERE.
THAT'S THE NEW CONCUSSION PROTOCOL.
6-8
THAVES