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Concussion in Children and Adolescents: Fact versus Fiction

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Overview

- Facts about Pediatric Concussion
 - Signs, Symptoms, Typical progression
- Post-concussive Interventions and Treatment
- Return to Play
- Return to Learn

Fact or Fiction:

Healthcare professionals have developed a concrete and specific definition of concussion.





Varying Definitions / Classification Systems

- There have been more than 25 different grading systems for concussion
- Recent consensus statements from the international symposia on concussion in sport have recommended forgoing grading scales/systems
- Current conceptualization examples:
 - Physical, cognitive, emotional, sleep
 - Cognitive (includes fatigue), vestibular, ocular, post-traumatic migraine, cervical, anxiety/mood related concussions
 - Somatic, Cognitive, Emotional/Behavioral
- Synonymous terms: Mild Traumatic Brain Injury (mTBI), Minor head injury, Minor head trauma



Concussion Defined

- Occurs when a forceful motion of the head results in a transient alteration of mental status or physiological brain function
 - Can occur with or without direct impact to the head.
 - Functional rather than structural injury.
- Note: mTBI (including concussion) accounts for at least 75% of all TBI in the U.S.



Pediatric vs. Adult Population

- Child and adolescent brains are still developing
 - May be more susceptible to sustaining an injury and more difficult to assess
- Young children may find “taking it easy” post-injury challenging
- May be more difficult to identify & assess for symptoms (limited short-term memory and brief attention spans are common during early childhood)
- Unfortunately, some still seem to believe that youth is a period of indestructibility



Pediatric/Adolescent Concussion

- Recent data has shown that rates of hospital admissions and ED visits for head injuries are higher in the child population than among adults.
- By the time children reach 10 years of age, 16% will have had at least 1 head injury requiring medical attention (Zemek, R. L., 2013).
- Majority of sport-related concussion occurs in children 18 years of age and younger (Comstock & Logan, 2012).
- True incidence of pediatric concussion is difficult to define because of the dependence on patient self-report.



Pediatric Concussion and Gender

- In terms of overall incidence, males sustain more concussions than females
 - Males traditionally participate in activities with the highest rates of injury (football, rugby, hockey)
- Girls are reported to experience higher rates of concussion than boys in similar sports (soccer, basketball)
 - Specific reason unknown
 - Theories:
 - Female athletes have weaker neck muscles and smaller head mass
 - Female athletes are more likely to report symptomatology

Fact or Fiction:

The literature has shown that children and adolescents are highly knowledgeable about the signs, symptoms, and recovery trajectory of concussion, making them reliable self-reporters of potential injury.





Common Concussion Symptoms

Headache/migraines

Neck Pain

Dizziness

Balance Problems

Sensitivity to Noise

Feeling like “in a fog”

Difficulty concentrating

Fatigue or low energy

Drowsiness

More emotional

Sadness

Pressure in the head

Nausea or vomiting

Blurred vision

Sensitivity to light

Feeling slowed down/Slowed processing speed

“Don’t feel right”

Difficulty remembering

Confusion

Trouble falling asleep

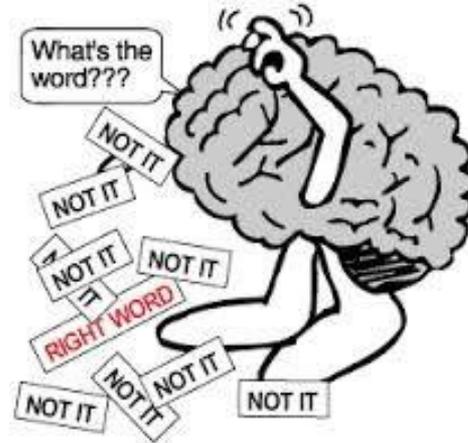
Irritability

Nervous or anxious

Poor attention and concentration

Fact or Fiction

Another common symptom of concussion is word finding difficulties.



Fact or Fiction

Headaches are the most commonly reported symptom following concussion.





Post-concussive Headaches

- Migraine headaches are usually unilateral and pulsating.
 - Moderate severity.
 - Exercise may increase symptoms.
 - May have nausea and light or noise sensitivity.
- Tension-type headaches are the most common. They are usually bilateral and described as pressure or a squeezing sensation.
 - Moderate severity.
 - Exercise does not increase the symptoms.
 - No nausea or light/sound sensitivity.



Dizziness, Vertigo, and Tinnitus

- Balance is a complex process and relies on input from the visual, vestibular, and proprioceptive systems.
- Dizziness and balance problems are a frequent complaint after mTBI.
 - Dizziness: light-headedness, an unstable feeling, or clumsiness
 - Vertigo: the sensation that the individual or the environment is moving.
- Tinnitus: ringing in the ears



Additional Concussion Symptomatology

- Temporary Loss of Consciousness (LOC) or Posttraumatic Amnesia (PTA)
 - Not a requirement
 - Seen in ~10% of concussions
- May see delayed onset of symptoms (“bruising” of the brain)
- Symptoms may be similar to those associated with depression, anxiety, ADHD, LD, and cognitive delays
 - In individuals with preexisting conditions, concussion may exacerbate those symptoms, making them more difficult to control



Post-Concussion Syndrome

- Persistent set of nonspecific symptoms (1-3 months post-injury)
 - Psychological: irritability, anxiety, depression
 - Cognitive symptoms: poor focus/attention, slowed processing speed and reaction time, memory impairments
 - Interrupted sleep pattern, fatigue
 - Migraines/Chronic Headaches
 - Chronic pain (cervical)
 - Ocular and vestibular difficulties: poor balance, dizziness, light and sound sensitivity



Post-Concussion Syndrome

- Headaches:
 - Presence of headache in the ED was found to be significantly related to the development of PCS
 - Headache most frequently endorsed symptom at 3 months post-injury
- Age
 - Adolescents may be at greater risk of developing PCS than younger children
 - More likely to be involved in severe mechanisms of injury
 - Better able to articulate their symptoms
 - Have been found to rate their symptoms more severely than their parents

Can you guess the percentage?

What percent of athletes report full symptom recovery within the first day?

- a) 7%
- b) 12%
- c) 21%
- d) 30%



Can you guess the percentage?

What percent of athletes report full symptom recovery in less than a week?

- a) 50%
- b) 60-70%
- c) 80-90%
- d) 100%



Can you guess the percentage?

What percent of athletes report symptoms beyond 1 month post-injury?

- a) Fewer than 5%
- b) 7-10%
- c) 15%





Typical Symptom/Recovery Progression

- The majority of concussions are uncomplicated and mild in nature
 - Most children will recover relatively quickly, without extensive evaluative or educational services.
 - 7-10 days is the typical recovery progression
- Children may still be mildly symptomatic one week following injury, but able to meaningfully participate in academics and social activities.



Prolonged Recovery

- As time passes the strength of the association between the neurobiology of the original injury and the ongoing symptoms diminishes
- Need to consider the importance of preexisting/premorbidity factors (mental health problems, ADHD, social-emotional adjustment) & current non injury factors (disposition, mental health, situational/environmental problems)
- It can become very difficult (nearly impossible) to determine what is causing, maintaining, or exacerbating the symptoms



Chronic Traumatic Encephalopathy

- CTE is clinically associated with memory, personality, and motor disturbance, pathologically with atrophy in multiple brain regions, and microscopically with extensive tau-based neurofibrillary tangles.
- Some media reports suggest that concussions cause late-life neurodegeneration; however, the vast majority of individuals who sustain concussions do not go on to develop significant neuropathology, so many other factors undoubtedly play a role (e.g., genetic vulnerability, age, and history of steroid and other substance abuse).
 - Identifying these other factors is a crucial next step in understanding CTE



Initial Diagnosis Following Concussion

- Evaluation in ER or doctor's office by medical personnel/physician
- Brief assessment of concussion (on the field, sideline, doctor's office)
 - Examples: SCAT3, ImPACT
 - Compare to baseline scores
 - Rivermead Postconcussion Symptom Inventory
 - Need to account for child's cognitive, physical, and emotional development, as well as their capacity to report their symptoms



Post-Concussion Intervention

- No strict/concrete evidence-based guidelines for children/adolescents recovering from concussion
- During acute post-concussion period the following is recommended:
 - Psychoeducation and reassurance for the individual and family
 - *Discrete* period of rest
 - Taking time off from sports
 - Avoiding vigorous play



Concussion Treatment: Rest

- A brief period of rest can allow the brain to heal and for symptoms to decrease/diminish before a return to normal activities.
- However, slow to recover children are at risk for secondary problems and consequences if their normal activities are curtailed for extended periods of time, which include:
 - Physical deconditioning, anxiety and stress, mild depression, irritability, and acting-out behavior at home and at school.



Rationale for Rest during Initial Period of Vulnerability

- Concussions are assumed to cause complex, interwoven cellular and vascular changes; resting the brain may help to facilitate the healing process.
- Individuals may experience headaches, dizziness, nausea, light and noise sensitivity, fatigue, hypersomnia/insomnia symptoms in the acute postinjury period; rest can be helpful in managing these symptoms
- Evidence is emerging in animal literature that there is a “temporal window” of vulnerability during which a second injury results in magnified cognitive and behavioral deficits and greater levels of traumatic axonal injury.



Fact or Fiction

Physical exercise/exertion should be avoided following concussion.





Concussion Treatment: Exercise

- Facilitates neuroplasticity
- Neurotransmitter systems and mental health:
 - Associated with changes in the neurotransmitter systems of the brain, which can in turn contribute to improved mood and to a general sense of well-being
- Cognitive functioning:
 - Aerobic exercise training had small improvements in attention, processing speed, memory, and executive functioning. Children have also performed better on tests of attention and executive functioning after an exercise session.
- Self-esteem
- Sleep, pain, and headaches



Montreal Children's Hospital Active Rehabilitation Program for Slow-to-Recover Individuals

The graded rehabilitation has 4 components:

1. Submaximal (60% max capacity) aerobic training provided for up to 15 mins
2. Light coordination exercises, up to 10 mins, tailored to the child's favorite activity or main sport
3. Visualization and imagery techniques are introduced
4. A home program allows continued training outside the clinic, thus facilitating school attendance and minimizing disruptions to the child's daily life (~20 minutes daily)

If at any time symptoms appear to increase, the activity is terminated.



Concussion Treatment: Headaches

- Treatment of headaches/migraines can include medications and nonpharmacological options.
- A holistic approach often incorporates exercise, sleep management, stress reduction and nutritional supplements.
- Behavioral interventions, including biofeedback and relaxation, are effective in pediatric migraine treatment.



Concussion Treatment: Vertigo and Tinnitus

- Vertigo and Dizziness
 - Pharmacological interventions such as anticholinergics or antihistamines
 - Vestibular rehabilitation: Exercise-based therapy or movement-based therapy to retrain the injured vestibular system; Reduces symptoms of disequilibrium and dizziness.
- Tinnitus
 - Difficult to treat. Treatments range from surgical cochlear implants to medications. Nonpharmacological interventions are being tested.



Concussion Treatments

- Vision therapy:
 - Tracking (Ocular Pursuits), Shifting gaze quickly from one point to another (Saccadic Movements), Focusing (Accommodation), & Eye Alignment (Binocular Vision)
- Physical therapy:
 - Increase strength and endurance
 - Implement return-to-play or exercise protocols

Fact or Fiction

Neuropsychologists are specially qualified to assist individuals through the concussion recovery process.





Neuropsychology Concussion Assessment

- Neurocognitive testing
 - ImPACT most commonly used measure (which also evaluates general symptoms - headaches, fatigue, etc.)
- Post-concussion/Follow-up testing assess for potential improvements in cognitive abilities and general symptoms over time
 - When recovery is not progressing in a typical fashion, neuropsychological assessment can also provide valuable information to guide treatment.
- Advocate for temporary school accommodations
- Assist in creation of a treatment plan



Neuropsychological Treatment

- Provide psychoeducation regarding:
 - Symptoms
 - Recovery Patterns
 - Rest Protocols
 - Various treatment options
- Psychotherapy to provide support, address changes in emotional functioning and help individuals navigate recovery process.
 - Cognitive Behavioral Therapy
 - Mindfulness
 - Biofeedback
 - Cognitive Rehabilitation



Importance of Education and Reassurance

- Ponsford et al. (2001) conducted a study on pediatric concussion outcomes
 - Group 1: children with mTBIs assessed at 1 week & 3 months postinjury. Received an information brochure describing symptoms and coping strategies.
 - Group 2: assessed at 3 months only; did not receive brochure.
 - Findings: The group that received the information booklet reported fewer symptoms at 3 months postinjury than the group that did not receive this booklet.
- Simply reviewing discharge instructions detailing the symptoms and course of concussion has been shown to decrease the incidence and severity of symptoms (Babcock et al., 2013)



Fact or Fiction?

No player, at any level, should return to play on the same day as the concussive injury.





Return to Play

- Individualized decision/process
- “When in doubt, sit them out!”
- Put simply, most experts would agree that the earliest an athlete should return to play is when:
 - No concussion-related symptoms or functional disruption is apparent at rest or during exertion
 - Neurological examination is normal
 - Neuroimaging is unremarkable, when conducted.

Fact or Fiction?

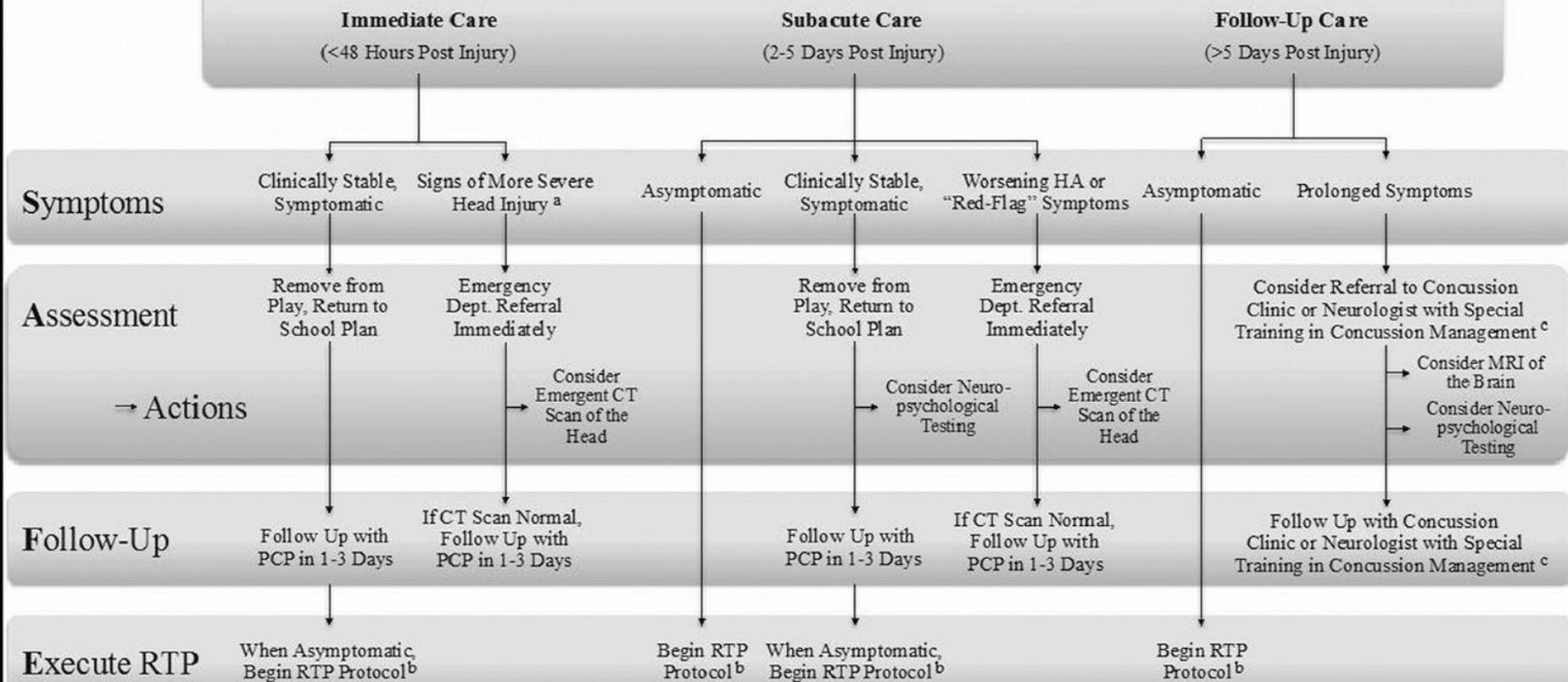
Once you have sustained 5 concussions, you should not return to contact sports.



Graduated Return-to-Play Protocol Recommended in the Zurich Consensus Statement on Concussion in Sport

Rehabilitation stage	Functional exercise at each stage of rehabilitation	Objective at each stage
1. No activity	Complete physical and cognitive rest	Recovery
2. Light aerobic exercise	Walking, swimming, or stationary cycling keeping intensity <70% MPHR. no resistance training	Increase HR
3. Sport-specific exercise	Skating drills in ice hockey, running drills in soccer. No head-impact activities.	Add movement
4. Noncontact training drills	Progression to more complex training drills (e.g., passing drills in football and ice hockey). May start progressive resistance training.	Exercise, coordination, cognitive load
5. Full-contact practice	Following medical clearance, participate in normal training activities	Restore confidence, assessment of functional skills by coaching staff
6. Return to play	Normal game play	Restore confidence, assessment of functional skills by coaching staff

Timing of Encounter



Fact or Fiction

A student can safely return to the classroom setting within one month of sustaining a concussion (or sooner).





Summary of Five-Step Protocol for School Reentry

Schoolwide intervention prior to any injury

Step 1: Educate

All school professionals, students and families should be provided with basic education about mTBI to promote appreciation and awareness of the potential impact of mTBI on school functioning

Child-specific interventions after TBI

Step 2: Communicate

After a child is injured and evaluated by a medical provider, that professional should provide documentation of the TBI and suggested accommodations to the school or to caregivers who can share with the school

Step 3: Monitor

Prior to, or on the first day back to school, a school professional should be identified as a case manager. The case manager should share injury-related information and suggested accommodations with all of the child's teachers and monitor the child's recovery.

Step 4: Create a safety net.

The case manager should work with the child's teachers to implement temporary accommodations upon return to school to manage common symptoms of mTBI and to develop a plan to address missed work.

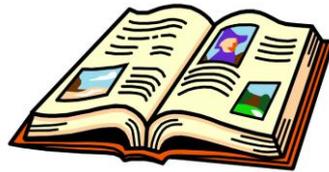
Step 5: Refer to health care providers.

For the child who does not recover as expected, the case manager should suggest referral to health care specialists with experience in TBI, who can work with the child's educational team to help guide and refine the educational plan.

Table from Kirk, J. W., Slomine, B., & Dise-Lewis, J. E. (2012).

Return to Learn: Accommodations

- Develop a transition plan:
 - Notify school of concussion injury prior to or upon returning to school.
 - Develop a plan for a gradual return-to-school day and demands
 - Provide a waiver of any missed assignments/exams or design a plan of assistance to support completion of missing assignments



Return to Learn: Accommodations

- Reduce demands, monitor recovery, and provide emotional support
 - Provide rest time or breaks during the day
 - Carefully consider upcoming standardized tests and advise student whether or not to reschedule
 - Excuse student from classes or activities that require rigorous physical activity until cleared by medical personnel
 - Reduce classroom and homework assignments





Return to Learn: Accommodations

- Reduce demands, monitor recovery, and provide emotional support (cont.)
 - When student is symptomatic, reschedule exams or coordinate and pace exams to no more than one per day
 - Negotiate timing of large assignments so that they do not occur at the same time
 - Assign a counselor to meet with the student at the end of each day at least for the first few days to check in with regarding emotional status (e.g., frustration tolerance, emotional lability), problem-solve, and assure that homework needs are being addressed



Return to Learn: Accommodations

- Other Examples of Common Academic Accommodations:
 - Copies of notes (notetaker)
 - Use test booklet in lieu of scantron
 - Limit computer use
 - Extended time for assignments and during exams
 - Separate, distraction-free room for testing
 - Break tasks, assignments into smaller units
 - Preferential seating



Return to Learn: Accommodations

- Special education law does not mandate that informal accommodations be implemented after mTBI. However most schools are more than willing to implement a few simple, temporary accommodations at the request of parents or health care professionals.
- Informal accommodations can easily be implemented and do not require the formal review and eligibility determination that are required for a Section 504 Plan or IEP.



Take-Home Messages

- Uncertainty & anxiety is understandable given mixed messages, lack of concrete definitions/treatment protocols, differing presentations, and concern about the health of youth brains.
- Despite growing concerns, the majority of concussions resolve within one week!
- Need to rely on common sense and clinical judgment.
- Consultation with health care professionals that specialize in concussion is essential!

References

- Babcock, L., Byczkowski, T., Wade, S. L., Ho, M., Mookerjee, S., Bazarian, J. J. (2013). Predicting postconcussion syndrome after mild traumatic brain injury in children and adolescents who present to the emergency department. *Journal of the American Medical Association Pediatrics*, 167(2), 156-161.
- Brooks, J. (2006). Concussion management programs for school-age children. In R. J. Echemendia (Ed.), *Sports neuropsychology: assessment and management of traumatic brain injury* (131-141). New York, NY: The Guilford Press.
- Carroll, L.J., Cassidy, J.D., Peloso, P.M., et al. (2004). Prognosis for mild traumatic brain injury: results of the WHO collaborating task force on mild traumatic brain injury. *J Rehabilitation Med*, 43(84-105).
- Comstock, R. D. & Logan, K. (2012). Epidemiology and Prevention. In M. W. Kirkwood & K. O. Yeates (Eds.), *Mild traumatic brain injury in children and adolescents: from basic science to clinical management* (303-320). New York, NY: The Guilford Press.
- Echemendia, R.J., Iverson, G. L., McCrea, M., Macciocchi, S. N, Gioia, G. A., Putukian, M., & Comper, P. (2013). Advances in neuropsychological assessment of sport-related concussion. *Br J Sports Med*, 47:294–298.
- Halstead, M. E., Walter, K.D., & The Council on Sports Medicine and Fitness. (2010). Clinical Report: Sport-related concussion in children and adolescents. *American Academy of Pediatrics*, 126(597-608).

References

- Iverson, G. L., Gagnon, I., & Griesbach, G. S. (2012). Active rehabilitation for slow-to-recover children. In M. W. Kirkwood & K. O. Yeates (Eds.), *Mild traumatic brain injury in children and adolescents: from basic science to clinical management* (281-302). New York, NY: The Guilford Press.
- Kirk, J. W., Slomine, B., & Dise-Lewis, J. E. (2012). School-based management. In M. W. Kirkwood & K. O. Yeates (Eds.), *Mild traumatic brain injury in children and adolescents: from basic science to clinical management* (321-340). New York, NY: The Guilford Press.
- Kirkwood, M. W., Yeates, K. O., Taylor, H. G., Randolph, C., McCrea, M., Anderson, V. A. (2008). Management of pediatric mild traumatic brain injury: A neuropsychological review from injury through recovery. *Clinical Neuropsychology*, 22(5), 769-800.
- Pardini, J. P., & Collins, M. (2006). Creating a successful concussion management program at the high school level. In R. J. Echemendia (Ed.), *Sports neuropsychology: assessment and management of traumatic brain injury* (142-159). New York, NY: The Guilford Press.
- Provance, Aaron J., et al. "Management of sport-related concussion in the pediatric and adolescent population." *Orthopedics* (2015).
- Wilson, P. E., & Clayton, G. H. (2012). Medical and pain management. In M. W. Kirkwood & K. O. Yeates (Eds.), *Mild traumatic brain injury in children and adolescents: from basic science to clinical management* (303-320). New York, NY: The Guilford Press.
- Zemek, R. L. Farion, K. J., Sampson, M., McGahern, C. (2013). Prognostics of persistent symptoms following pediatric concussion. *The Journal of the American Medical Association*, 167(3), 259-265.