Concussion in Children and Adolescents

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CAPA2017 Ottawa

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No financial ties to disclose -

NO INVESTMENTS OR RELATIONSHIPS THAT COULD BE SEEN BY A REASONABLE PARTICIPANT AS HAVING THE POTENTIAL TO INFLUENCE THE CONTENT OF THIS EDUCATIONAL ACTIVITY
Case Study - Rowan Stringer, a highschool Rugby player from Ottawa,

May 3rd at a highschool rugby tournament, last game of the day was tackled and removed from game complaining of a headache

Following Monday (May 6), feeling great, played in the game after school were someone stepped on her head and the headache returned.

She did not tell anyone of this return in symptoms

Wednesday (May 8), she had yet another game, which would be her last. She was tackled to the field, which resulted in a loss of consciousness that she never recovered.
Unsuccessful in relieving swelling

Death from Second Impact Syndrome due to multiple concussions suffered within a short period of time.

A coroner’s inquest resulted in 49 recommendations

Rowan’s Law, passed unanimously on June 7, 2016, is a private members bill put forth by Conservative MPP Lisa MacLeod (Napean-Carleton)

To learn more about Rowans Law visit [http://rowanslaw.ca/](http://rowanslaw.ca/) and [http://nationalpost.com/features/rowans-law](http://nationalpost.com/features/rowans-law)
Our Learning Objectives

The PA shall explain the etiology, pathophysiology, diagnostic workup (including differential diagnosis), management, and follow up of Traumatic Brain Injuries/concussions in the pediatric population.
A Canadian ED study of head injuries reported that 53.4% of head injuries in children 10 to 14 years of age and 42.9% of head injuries in adolescents 15 to 19 years of age were sport-related. Concussions account for 9% to 12% of injuries in high school athletics.

Paediatric Child Health 2014;19(3);153-8
Canadian Guideline on Concussion in Sport
Developed by Parachute and its Expert Advisory Concussion Subcommittee – in the APP

http://www.parachutecanada.org/injury-topics/item/canadian-guideline-on-concussion-in-sport
A concussion is a brain injury that cannot be seen on routine x-rays, CT scans or MRIs. Any blow to the head, face or neck, or a blow to the body that jars the head, could cause a concussion.

Symptoms of a concussion can appear immediately or a few days after the impact.

Concussions can appear as a variety of symptoms, and each person might experience concussion in a different way.
Defining Concussion

A trauma-induced brain dysfunction
without demonstrable structural injury on standard neuroimaging.

A complex pathophysiological process affecting the brain, induced by biomechanical forces;

Resulting the rapid onset of short-lived impairment of neurological function that resolves spontaneously
Concussion Overview

a common injury among children and adolescents playing sports. Those who sustain a concussion should be removed from play immediately and medically evaluated ASAP.

Cognitive and physical rest are recommended to allow symptoms to resolve.

Cognitive rest may require temporary school absence and/or a modified class work or homework load.
Clinical Manifestations and Diagnosis
Signs and Symptoms of Concussion

- Dizziness
- Headache,
- Balance problems
- Neck pain,
- Loss of Consciousness
- Nausea or Vomiting
- “Pressure in the head”
- Sensitivity to light,
- Seizure or convulsion
- or Confusion
Symptoms of Concussion

Any new neurologic symptom that develops following sports-related head trauma makes the diagnosis of concussion.

As an example, a soccer player who heads a ball and then reports dizziness or feeling "slow" has a concussion.
Features of sport-related concussion

Symptoms, Behavioural, Cognitive, Sleep

Organizing related symptoms into clusters makes initial evaluation and surveillance easier.
1. Physical

Headache, nausea, vomiting, balance problems, incoordination, dizziness, visual problems, fatigue, photophobia, phonophobia, numbness/tingling, neck pain.

An on-field complaint of dizziness by the athlete is among the best predictors of concussion with a protracted recovery.
2. Cognitive

Feeling mentally foggy or slow, disorientation, difficulty concentrating, difficulty remembering, slow or incoherent speech, word-finding difficulty.

Not just standard teenage years
3. Emotional

Irritability, sadness, emotional lability, nervousness

Remember: A post event presentation is common
3. Sleep-related

Drowsiness
Higher Risks come from:

- Gender
- Double hit
- Trauma with rotational forces
- Second hit

This "second blow" phenomenon is distinct from Second Impact Syndrome, a rare but often fatal neurologic injury.
Concussion Recovery Is Slower in Girls, and Concussions missed

Berlin’s 5th International Consensus Conference on Concussion in Sport

Cited evidence girls were more likely to suffer concussions that required a more lengthy recovery period than their male counterparts did.

Median recovery time for girls was 28 days—more than double that of boys,
Median number of days female athletes remained symptomatic (28 days) when compared with male athletes (11 days) (P<.001).

No difference was found in symptom duration between age groups.

No statistically significant differences were found in symptom duration between the type of sports played.

Why the Bias?
We don’t screen or assess because female?
We underrate women’s sports due to our inherent biases?
Why? *Purposed* that Biomechanically,

Females may be at higher risk for concussions because their necks are smaller and do not absorb shock as well as the necks of males.

Females had 26% less total mass in their head and neck, and displayed significantly greater head-neck segment peak angular acceleration and displacement.

Females have a greater basal rate of glucose metabolism.

Female athletes might exhibit prolonged impairments compared with male athletes because females have a greater basal rate of glucose metabolism.
Double Hit example
Ice hockey player who is checked by a shoulder strike to the player's head (first hit), followed immediately by a fall in which the checked player's head strikes the ice (second hit).
High likelihood of concussion, and severe dysfunction with prolonged recovery. E.g. football player spun forcefully to the turf causing the occiput to strike the ground as it is moving in an arc.
Second Hit

A previous blow to the head sustained either earlier the same day (injured early in the first period and again late in the game) or in the days or weeks prior appears to lower the threshold for a more severe concussion.
Why the need for worry?

Fatal diffuse cerebral swelling, known as malignant brain edema syndrome or second-impact syndrome,
a rare phenomenon believed caused by a loss of autoregulation in the brain’s blood supply,
causing rapid cerebrovascular congestion and increased intracranial pressure, with progression to brain stem herniation, coma and death.
The cognitive effects of concussion

Decreased attention and concentration, reduced information processing speed, and impaired memory and learning.

Negatively impact a child’s or adolescent’s ability to learn and attend to school work.

i.e Fall behind Peers – Bullying & Depression
A Problem and that for our patients is...

In the past, severity of concussion was graded numerically or with terms, yet grading scale evidence suggests that a brief loss of consciousness in association with concussion does not predict clinical course or long-term cognitive impairment.
Send me in Coach....

The absence of loss of consciousness in a young athlete who has sustained a concussion should not be used to justify more rapid return to play.
Concussion results from a rapid rotational acceleration of the brain. Direct impact to the head is not required. Location of impact does not appear to correlate with concussion outcomes. Hypothesized to cause a shear strain of the underlying neural elements.
Neuronal depolarization – Opening of sodium-potassium channels within the axonal membrane of affected neurons leads to a massive influx of sodium and efflux of potassium. Calcium-dependent release of excitatory amino acids, particularly glutamate, further stimulates potassium efflux. This process results in the effective **depolarization of affected neurons, leading to depolarization of downstream neurons, a phenomenon similar to spreading depression**.

Local lactic acid accumulation – As ionic homeostasis is disrupted, affected neurons are suppressed and cannot fire normal, purposeful action potentials until ionic homeostasis is restored. Sodium-potassium pumps work to restore homeostasis, a process that requires adenosine triphosphate (ATP). Given the massive degree of the induced ion fluxes, a large amount of ATP is required to operate the sodium-potassium pump. This **increased demand for ATP**, which is derived ultimately from glucose, results in an increase in glycolysis, **leading to local lactic acid accumulation**.

Decreased cerebral blood flow with mismatch of cerebral glucose supply and demand – Concomitantly, there is a decrease in cerebral blood flow for a period of days to weeks after concussion. Since glucose is delivered to the brain via the blood stream, the increased demand for glucose and its end product, ATP, go unmet. **This supply-demand mismatch is thought to result in the cognitive dysfunction and symptoms of concussion.**
Krebs Cycle Strikes Again
For the rest of us

Hitting Brain Bad!

Comparative Study F Age 12-21

Menstrual dysfunction during follow-up was more common in the concussion group than the non-head injury group 23.5% vs. 5.0%; odds ratio 5.85. Concussion had higher risk for intermenstrual interval <21 days (OR, 5.60) and bleeding duration <3 days (OR, 2.30).

Questioning young women who have suffered concussions about changes in menstrual patterns will allow for appropriate referral for menstrual dysfunction and should become usual practice in all pediatric healthcare settings.

Cowden et al. JAMA Pediatr 2017 Jul 3
Simple orientation questions

(e.g. person, place, time) alone have NOT been shown to be as helpful in acute sideline assessment.

Observational studies suggest that amnesia, particularly anterograde amnesia, predicts more severe injury.
Performance of the Physical Examination and Assessment

**Observation** – signs of disequilibrium and lack of coordination.

Inattentiveness, confusion, atypical emotionality (eg, crying or laughter that is inappropriate or out of character for the athlete), or problems following instructions or focusing on a task.
Memory and attentiveness

After the initial symptom review, assess memory and attentiveness. Deficits in recall and concentration are common with a concussion. This assessment is best done using a brief standardized neuropsychological test.

E.g. The Maddocks questions found in the Standardized Assessment of Concussion (SAC)
Sideline Assessment – Maddocks Score

“I am going to ask you a few questions, please listen carefully and give your best effort.”

Modified Maddocks questions (1 point for each correct answer)

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

Maddocks score

Maddocks score is validated for sideline diagnosis of concussion only and is not included in SCAT 2 summary score for serial testing.

http://cces.ca/sites/default/files/content/docs/pdf/scat21.pdf
Neurologic examination

Cranial nerve testing

Strength and sensation of upper and lower extremities

Vestibular and oculomotor assessment
  - impaired vestibular or oculomotor function progressively worsen with increased neurocognitive stress becoming symptomatic & often worse at the end of an evaluation than the beginning.

Balance assessment
To Sum up and Diagnose

1. Hear the Story
2. Review the Symptoms
3. Examine
4. Effect on Life
5. Explain Results and Risks

Explain Results and Risks
INDICATIONS FOR EMERGENCY DEPARTMENT EVALUATION

- Prolonged loss of consciousness
- Concern for cervical spine injury
- High-impact or high-risk mechanism for intracranial bleed
- Examination findings suggestive of skull fracture
- Post-traumatic seizure
- Any significant acute worsening in the patient's condition
Differential Diagnosis

- Migraine
- Non-concussive headache
- Anxiety
- Heat Illness
- Exertional Sickle cell crisis or other disease
Treatment

► No return to play ◄

Relative neurocognitive rest ("prescribed rest")

Additional limitations for a short period of time (eg, no phone, no test taking, no texting, no TV, no computer) may be helpful.

It is now generally accepted that total stimulus deprivation ("cocoon therapy") and protracted rest is ineffective and may be detrimental to recovery.
Management of somatic symptoms appears safe to treat somatic symptoms, particularly headache, with over-the-counter analgesics.

nausea following a concussion generally subsides quickly and does not require aggressive medical therapy

over-the-counter anti-nausea products (eg, fructose, dextrose, and orthophosphoric acid combination; bismuth) to reduce their symptoms.

ensure that a responsible adult is with the concussed athlete for the first six to eight hours after concussion
It is not necessary to advise waking an athlete every two to three hours throughout the night for reassessment. Interferes with the cognitive rest needed for recovery, Difficult to assess accurately the cognitive status of a concussed athlete who is awakened every two to three hours.

Allowing the athlete to sleep, looking in every few hours for signs of distress
  ◦ (eg, labored breathing, thrashing about).
Assessment must include a careful physical examination; cognitive assessment alone is not sufficient.

Assessment of memory and attentiveness, and a systematic neurologic examination

- Cranial nerves,
- Strength and sensation of all extremities,
- Oculomotor and vestibular function, and balance.)
Long-term follow-up
Parachute: After a Concussion Guidelines for Return to Play

1. No activity, only complete rest
2. Light Aerobic Exercise
3. Sport Specific Activities
4. Begin Drills without Body Contact
5. Begin drills with body contact
6. Game Play

Each Steps takes a minimum of one day or until symptoms gone
Summary: A Concussion is:

A complex pathophysiological process affecting the brain from trauma - direct blow or a blow to the body that transmits force to the head (eg, whiplash, rotation)

Manifest in a wide variety of symptoms and signs that may or may not include loss of consciousness.

No gross structural abnormalities are seen with neuroimaging.

Symptoms may include physical, cognitive, emotional or sleep-related findings.
References

UptoDate: Josh Bloom, Jim Blount - Sideline evaluation of concussion Dec 2016 and


Ontario Neurotrauma Foundation 2014 Guidelines for Diagnosing and Managing Pediatric Concussion

Further Information is found in UpTo Date library
Provided “Parachute Guideline”
This is an evolving field of study

And There is an App
Concussion Ed

Free access to critical concussion resources.

This free mobile app was primarily developed for youth, parents and educators, but covers concussions throughout different scenarios for a wide audience. Available in English and French, Concussion Ed is organized into Prevent, Recognize, Manage and Track.

Concussion Ed is available in the Apple App Store as well as Google Play for Android devices. Concussion Ed is also available via a web-based version for Blackberry and Windows users.
A Background and Perspective Video