Concussion Management: Slow-to-Recover Children and School Performance

Overview

1. The Anatomy of a Concussion
2. Signs & Symptoms
3. Treatment Overview
4. Slow-to-Recover Children
5. Concussions in School

Objectives

1. How and why
2. What to look for
3. Short and long-term concerns
4. Return to (play)
5. Slow-to-recover in school
Secondary Objectives

- The Brain-Based nature of a concussion
- Why so much ambiguity exists in the field of concussion management

"No evidence-based guidelines exist for treatment and rehabilitation services for children and adolescents who sustain or recover following a mild traumatic brain injury." (Iverson, G.L., Gagnon, I., & Griesbach, G.S, 2012).

Definition

- "A concussion is defined as a complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces..."

Consensus Statement on Concussion in Sport
4th International Conference on Concussion in Sport
Held in Zurich, November 2012

(Paul McCrory, MBBS, Ph.D., William Meeuwisse, MD., Ph.D., Karen Johnston, MD., Ph.D., Jiri Dvonak, MD., Mark Aubry, MD., Mick Mollay, MD., and Robert Cantu, MA, MD.)

Simple Definition

- Impulsive force transmitted to the brain
  - Body Blows
  - Functional disturbance vs. structural
  - Simply: Force (times) Acceleration
Anatomy of a Concussion

- Frontal Lobes: Higher-Order Functions
- Parietal Lobes: Sensory and Motor Integration
- Temporal Lobes: Perception, language, memory
- Occipital Lobes: Visual Integration
- Cerebellum: Motor Coordination
- Brain Stem: Homeostasis

Force = Motion in the brain
- Rotational Force: The head moves against the force of gravity
- Rotational force in or around the brainstem is most severe
  - Disruption in Reticular Activating System (RAS)
  - Brainstem involvement = at-risk for disrupted basic bodily functioning

Neuron: The basic cell of the nervous system
Focus: The Axon

Focusing on activity in the synaptic gap at the level of neurotransmission.
Diffuse Axonal Injury (DAI)

A mTBI can occur whenever:
- The brain hits the skull
- A Diffuse Axonal Injury (DAI) occurs
  - The brain moves against the force of gravity – causing axonal shearing, cerebral swelling, and/or subdural bleeding

Diffuse Axonal Injury (DAI)
Rotational Force: Physical properties of brain cells are subjected to change, damage, and/or death.

Diffuse Axonal Injury (DAI)
Once a brain cell (Neuron) is subjected to axonal shearing, the cell is prone to death and disrupted downstream communication.

This occurs because the cell can no longer communicate with each other via chemical transmission, which can result in a loss of function.
Physiology of a Concussion

- Action Potential: A Neuron’s electrical charge changes by ions shifting in and out of the cell.
- Stretched axons = uncontrolled ionic fluxes
- Too much K+ and Ca(2+) leaving cell
- Massive Depolarization: Pumps on overdrive
- Uncontrolled Neuronal Activity = Hypermetabolism = Depleted Energy Production and Availability

Physiology of a Concussion

- Uncontrolled Neuron: Disrupted neurotransmission, intracellular functioning, hypermetabolism, excitotoxicity
- Essentially a major disruption in the brain’s homeostasis (stability)
- If homeostasis is disrupted in or around the brain stem, homeostasis will likely be disrupted throughout the body.
- Also occurs during recovery and exercise
- Therefore: Infinite individual differences

Prevalence Rate Problems

1. Under-reporting of symptoms
2. Need for loss of consciousness (LOC) – 90%
3. Need for Post-Traumatic Amnesia (PTA)
Signs and Symptoms

4 Domains of Symptoms

1. Cognitive Symptoms
2. Physical Symptoms
3. Emotional Symptoms
4. Sleep

Cognitive Symptoms

- Attention/Concentration Deficits
- Short-Term Memory Difficulties
- Information Processing Speed
- Executive Functioning Deficits
- Neurofatigue

Subtle Cognitive Symptoms

- The inability to multitask or process information efficiently
  or
- "It feels like the world is going too fast!"
Signs and Symptoms Continued

Physical Symptoms

- Headache
- Dizziness
- Nausea/vomiting
- Vertigo
- Photophobia
- Tinnitus
- Balance Disturbances
- R/O Migraines ***

Signs and Symptoms Continued

Obvious and long-term physical symptomology

- Any change or loss in functioning = immediate need for physician oversight

Signs and Symptoms Continued

Emotional Symptoms

- Labile mood (swings)
- Loss of pleasure
- Isolation
- Hyperactivity
- Tearfulness
- Impulsivity
- Adynamia, or a loss of initiative
- Restlessness
- Apathy

Emotional States

- Depression
- Anxiety
- Hypomania
- Changes in personality
- Changes in Libido
Signs and Symptoms Continued

SLEEP!

Most neglected sign of concussion management

Signs of sleeping difficulty, secondary to a concussion may include:

- Insomnia
- Drowsiness
- Difficulty falling asleep
- Changes in pattern

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Signs and Symptoms Continued

Take-Home

How can I recognize a concussion?

Any blow to the head or body that results in rapid movement of the head, with subsequent changes in a patient's behavior, cognition, sleep, or physical functioning

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Concussion Management

- Most Important Factor: Multifaceted
- Collaboration is essential
- Involves consultation with multiple sources
- Always err on the side of caution
Interdisciplinary Team
The Concussion Management Leader (CML)

Single or Dual Leader?
Single Leader: aka Concussion Management Leader (CML) vs. Dual Leaders: AL: Academic Leader ML: Medical Leader

Concussion Management
Treatment Options
1. Cognitive Rest
2. Limited Activity Under Parental Supervision
3. Treatment of Symptoms
4. Active Rehabilitation

Concussion Management
Cognitive Rest
- Post-Injury: All of the brain’s energy is devoted to restoring function
- Cognitive exertion can actually compromise the restoration process
- Concerns regarding energy production, nerve cell communication, hypermetabolism, cerebral blood flow
- Eliminates risk factors while within the “temporal window”
Stage 1: Rest during “Temporal Window”

- Research shows that a second injury is more likely during initial days or weeks following injury
- A second injury increases likelihood of behavioral concerns and axonal injury
- Rest prevents possible magnification of pathophysiology secondary to reducing energy demand and hypermetabolism opportunities

Stage 2: Education and Reassurance

- Research shows patients who participate in education report fewer symptoms 3 and 6 months post-injury
- Education: Common symptoms, course of symptoms, reassurance, and coping strategy training

Stage 3: Active Rehabilitation

- Aerobic Exercise (60% exertion)
- Coordination Training
- Visualization
- Home Program
- Clinical Support

All until asymptomatic for 1 week

(Montreal Children's Hospital Rehabilitation after Concussion Program)
Active Rehabilitation

Slow-to-Recover Children

Why Active Rehabilitation?
1. Neuroplasticity through BDNF
2. Neurotransmitter Changes
3. Improvements in cognitive functioning
4. Self-Esteem Benefits
5. Improved Sleep
6. Decreased Pain and Headaches
7. Neuroprotective Qualities

Still – More research is needed

The Million-Dollar Question: When?

- Rat Study
  - Found after 2 weeks of rest
  - 1 week = increased behavioral dyscontrol
  - Delays are severity-dependent
  - Goal: Zero unneeded demands on the cell’s energy or metabolic functions
  - However: There still is no prescription for a time-table
  - Implications: Intervention too early significantly increases chances of future problems across all domains

Management Guidelines

Updated information from CISG-IV, Zurich 2012
1. Symptoms present = Cognitive rest
2. Best anecdotal evidence = School activities with light at-home exercise
3. Regardless, majority of second injuries within 10 days
4. After 6 weeks, active rehabilitation likely recommended
Remember!

Special Populations

Children and Adolescents
- 13 and under report symptoms differently
- Requires patient and parent reports
- Need for pediatric neuropsychologists secondary to normative differences
- No sports until full integration into school
- Closer monitoring of exercise
- More conservative RTP

Follow-Up Care

Long-Term Concerns
- Increased risk of psychological and neurological disorders
- Increased Susceptibility/Generalized Concussion
- Behavioral dyscontrol
- Generalized concussion
- Downstream effects
  - Goal: Eliminate Risk Factors

Concussions in School
- Symptoms may be subtle
- Even more so in individuals with disabilities
- Behavioral manifestation most common
- Communicate within the team
- Educate family
  - Opinion: Children with disabilities may be the most “at-risk” population
**Academic Accommodations**

1. Emphasis on cognitive processes vs. content
2. Modify schedule conducive to needs
3. Eliminate unneeded distractions and demands
4. Self-paced and multisensory presentations for reading comprehension
5. Extra Time

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**Frequent Accommodations**

- Provide external organization
- Note-taking accommodations
- Preferential seating
- Breakdown assignments
- Oral or alternative testing
- Essential to have successes!
- Positive praise
- Continuity across classes

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**Last Stages of Accommodations**

- Response-To-Intervention
- 504 Accommodations Plan
- Individualized Education Plan
Return To Play Guidelines

- 25 different RTP attempts ('01)
  1. No activity
  2. Light exercise
  3. Sport-Specific exercise
  4. Non-Contact
  5. Full-Contact
  6. RTP
  * All 24 Hour Steps
  * mTBI Symptoms = Not Recovered


Return To Play Considerations

1. Number of Concussions
2. Proximity
3. Age
4. Learning Disability?
5. Biomechanical Forces Involved

Concussions in School

Return to Play? In School That Is...

- Step-Wise
- Eliminate sustained activity
- Escape plans
- Eliminate Computers
- Avoid Testing
- Team Approach
- Limit Multitasking
Wrapping Up

Questions?

CISG-IV Questions Answered

Q: If there is an injury, but it’s not a concussion, what is it?

A: Concussions can evolve and it is not possible to rule out concussion as a transient neurological symptom; therefore, the appropriate concussion protocol should be implemented (i.e., cognitive symptoms are not necessary for diagnosis).

CISG-IV Questions Answered

Q: Are any tools available that can exclude a concussion on the day of injury?

A: Concussion diagnosis is multifaceted. Although neuropsychological testing is often sensitive to concussion, it should never be used in isolation. The opposite is also true. Therefore, diagnosis or rule-out, is often based on clinical judgment, which requires a collaborative and multifaceted approach.
Q: What is the best practice?
A: Recognition of injury; assessment of symptoms, cognitive functioning, and cranial nerve function, and balance. Symptoms are often delayed; therefore, serial assessment and collaboration is essential.

Q: Are brief, computerized assessment tools sufficient for diagnosis?
A: Although they are very valuable, especially for on-the-field concerns, they should never be used in isolation, nor as a substitute for a neuropsychological evaluation.

Q: What advancements are available for concussion assessment and management?
A: Although the research is not quite there, many advancements are showing promise. These include: application-based software, robotics (sensory assessment), telemedicine, eye-tracking, functional imaging, and head impact sensors.
Q: Should any population be assessed differently?

A: Yes, children. Symptoms in children may take longer to present, may be more subtle, and often require parental involvement and consultation. Although the single rule of “When in doubt, sit ‘em out,” should govern all decisions, children are especially vulnerable to misdiagnosis.

Q: Equipment or Policy?

A: No standard headgear in rugby or mouth guard in football can significantly reduce risk of concussion. No association with neck strength has been fully-validated. There is evidence that eliminating body checking and introducing fair play rules in peewee hockey is beneficial. It’s going to take major changes in equipment, a continued and devoted dedication to public education, and research regarding the effect or rule changes to make the most measurable improvements.

It must be emphasized that the previous slides entitled, “Questions Asked,” were summarized and taken directly from the Consensus statement on concussion in sport: The 4th international conference on concussion in sport held in Zurich, November 2012.

For further answers to frequently asked questions, please refer to McCrory et al., (2012).
References

- U.S. Department of Health and Human Services Centers for Disease Control and Prevention. *Heads Up to Schools: Know Your Concussion ABCs*.
- Illustration courtesy of Journal of Radiology Nursing, Volume 31, Issue 2, June 2012 42-52
- Illustration courtesy of Google Images, via trialexhibits.com

Conclusions for RTP Guidelines

  1. **Step-Wise Rehabilitation**
  2. mTBI’s are diffuse injuries and can affect all aspects of functioning; therefore, withdrawal from environmental demands is essential
  3. Importance of low-level exercise (yoga, Pilates)
  4. Enhance symptoms (balance, etc.), often with psychopharmacology
  5. Adaptive Equipment (vestibular rehabilitation, visual, etc.)
  6. “Pros and cons” of team involvement
  7. Psychological techniques to manage sleep, affective disorders, etc.