Tackling concussions

What’s the hype?

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Objectives

• Discuss how the diagnosis of a concussion is made and describe the mechanism
• Reduce practice variation and provide a structured approach to the management of the patient with a concussion
• Provide an approach to patient and family education
Concussion

Traumatically induced physiological disruption of brain function manifested by at least one of the following:

- LOC
- Amnesia
- AMS
- Focal Neuro Deficit
- Confusion LOC <30 m
- Amnesia < 1d
- GCS
- Confusion
- LOC
- AMS
The Official Definition

Concussion is defined as a complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces. Several common features that incorporate clinical, pathologic and biomechanical injury constructs that may be utilized in defining the nature of a concussive head injury include:

1. Concussion may be caused either by a direct blow to the head, face, neck or elsewhere on the body with an "impulsive" force transmitted to the head.

2. Concussion typically results in the rapid onset of short-lived impairment of neurologic function that resolves spontaneously.

3. Concussion may result in neuropathological changes, but the acute clinical symptoms largely reflect a functional disturbance rather than a structural injury.

4. Concussion results in a graded set of clinical symptoms that may or may not involve loss of consciousness. Resolution of the clinical and cognitive symptoms typically follows a sequential course; however, it is important to note that, in a small percentage of cases, post-concussive symptoms may be prolonged.

5. No abnormality on standard structural neuroimaging studies is seen in concussion.
Emotional
More emotional
Sadness
Nervousness
Irritability

Physical Symptoms
Headaches
Visual Problems
Dizziness
Noise/Light Sensitivity
Nausea

Cognitive Symptoms
Attention Problems
Memory Dysfunction
Fogginess
Fatigue
Cognitive slowing

Sleep Disturbance
Difficulty falling asleep
Sleeping more/less than usual
Epidemiology

Emergency Departments

Fall

1.5 million traumatic brain injuries/year

MVC

1-2% of the US population

80% are mTBI (concussions)
Sports-related concussion

According to a study published today in Pediatrics, the journal of the American Academy of Pediatrics, the number of emergency room visits for concussions by 8- to 13-year-olds doubled, and more than doubled for 14- to 19-year-olds though participation in organized team sports declined between 1997 and 2007.

Estimated emergency department visits for sports-related concussion (SRC)

<table>
<thead>
<tr>
<th>Year</th>
<th>SRC in organized team sport, ages 8-13</th>
<th>SRC in organized team sport, ages 14-19</th>
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<tr>
<td>'97</td>
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Source: Pediatrics

Post-Gazette
23% of returning military personnel suffer traumatic brain injuries

“Most” are mTBI (concussions)
Epidemiology
Sports

300,000 mTBI/year
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<tr>
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<td>2</td>
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<tr>
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<tr>
<td>Wrestling</td>
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<td><strong>Total</strong></td>
<td><strong>39</strong></td>
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Why all the press?

- Increasing Awareness
  - Many high profile athletes are upfront about their concussion
  - Good role models
  - Education of coaches and parents
  - Devastating acute and long term effects

- Increasing Incidence
  - Kids are bigger and faster than ever before
Sequalae

- Acute: Second Impact Syndrome
- Long term: Dementia, depression
- Earlier onset of Alzheimer’s and other memory-related diseases
Second Impact Syndrome

- 4/29/2010 – NCAA urges institutions to have a Concussion Management Plan requiring clearance by a team doctor
Long term consequences

- 2005 – UNC - Chapel Hill - data from more than 2,550 retired professional football players
- 61% had experienced at least one concussion during their career
- 24% had >= 3
- Earlier onset of Alzheimer’s disease among these men than the general male population
Memory disorders

• University of Michigan’s Institute for Social Research at the request of the NFL

• 1,063 retired NFL players completed a survey

• Younger players (30 to 49 years) had a rate of 1.9% – 19 times that of the national average of 0.1%.

• 6.1% of players age 50 and older had been diagnosed with a dementia-related condition – Five times the national average of 1.2%
Chronic Traumatic Encephalopathy
What’s being done?

- **NFL**
  - October, 2010 Congressional Sub-committee
  - Must be cleared by team physician and an independent neurologist before returning to play

- **MLB**

- **NCAA**
  - No RTP on the same day
  - Focus on educating coaches, staff, athlete
The RI experience

• 7/10 - all school coaches and volunteers must receive concussion training

• Coaches must remove any player from a game or practice that exhibits signs or symptoms of a concussion

• The player must obtain written authorization from a physician before being allowed to return to play
Biomechanical Mechanism

- Three components
  - contact
  - acceleration-deceleration
  - rotational
A. Trauma causes the axon to twist and tear.
B. The result is permanent death of the brain cell.
The cellular milieu

Primary Insult

• Pathologic **release of excitatory neurotransmitters** that leads to loss of cell wall integrity
• Leads to influx of sodium and efflux of potassium
• **Alters cell pH**
• Calcium influx
• **Cell Damage** ← **Vulnerable Cells**
• Cells die and release cytokines
Secondary insult

• The cytokines released lead to an upregulation of the inflammatory response

• Concussive symptoms get worse 6-24 hours after the injury
Metabolic effects

• Acutely, the glucose requirement of the cell increases
• Mild and moderately injured cells can upregulate Na/K ATPase-dependent proteins to restore intracellular pH but these enzymes are fueled by glucose
• HOWEVER, cerebral blood flow to the brain is reduced post injury
• So, the brain needs more glucose to restore pH and prevent calcium influx but the brain is getting less than a basal level of blood flow
• In animal models, this mismatch lasts about 2 weeks
PERIOD OF VULNERABILITY
Another concussion during this period can lead to irreparable damage or death.
Mismatch? Big Deal….

- During this mismatched phase, the brain is very vulnerable to more stress
- Physical – mild trauma will worsen the cell injury cascade and mimics significant injury
- Cognitive – concentration increases the metabolic demands of the cells
RED FLAGS
MONITORING TOOLS
Assessment tools

• GCS – Glasgow Coma Scale
• ACE – Acute Concussion Evaluation
• SAC – Standardized Assessment of Concussion
• Rivermead Post-Concussive Symptom Questionnaire
• ImPACT
A clinical diagnosis with an objective tool

• Baseline neuropsych testing
  – ImPACT testing

Immediate Post-Concussion Assessment & Cognitive Testing

• 20 min online test
  – Symptom Checklist
  – Tests memory, speed & processing time
## ImpACT® Clinical Report

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<tr>
<th>Exam Type</th>
<th>Baseline</th>
<th>Post-concussion</th>
<th>Post-concussion</th>
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### Composite Scores *

<table>
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<tr>
<th>Composite</th>
<th>Baseline</th>
<th>Post-concussion</th>
<th>Post-concussion</th>
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</thead>
<tbody>
<tr>
<td>Memory composite (verbal)</td>
<td>93</td>
<td>66</td>
<td>57</td>
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<tr>
<td>Memory composite (visual)†</td>
<td>70</td>
<td>41</td>
<td>49</td>
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<tr>
<td>Visual motor speed composite</td>
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<td>46.38</td>
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<tr>
<td>Reaction time composite</td>
<td>0.54</td>
<td>0.60</td>
<td>0.66</td>
</tr>
<tr>
<td>Impulse control composite</td>
<td>8</td>
<td>14</td>
<td>10</td>
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<tr>
<td>Total Symptom Score</td>
<td>0</td>
<td>14</td>
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</table>
TREATMENT AND RECOVERY
Early Goals

- Protect brain vulnerability
- Basis for complete cognitive and physical rest
HOW LONG ARE THEY OUT?
Recovery Confounders

- Not everyone recovers at the same rate
- Are there things that affect the rate of recovery?
  - Age
  - Concussion history
  - Sex
  - Comorbid conditions
Recovery confounders

Age

• Younger athletes take longer to heal
  – Developing brain is more sensitive to the excitatory NT and the cascade that follows
Age

• Average return to baseline testing
  – Adults and pro athletes: 3-5 days
  – College athletes: 5-7 days
  – HS athletes: 10-14 days
Recovery confounders
Concussion History

- History of 3 concussions
  - More severe on field presentation
  - Delayed recovery times
  - Threefold increase for future concussion
  - Long term neurological deficits/decline in cognitive performance
Recovery confounders
Boys and girls are different
Recovery Confounders

Comorbid conditions

**Conditions**
- Migraine headaches
- Attention deficit disorder
- Sleep disturbances
- Depression
- Anxiety
- Mood disorders

**Clinical outcome**
- More acute postinjury neurocognitive deficits
- Individuals with comorbid conditions have less “reserve” and are unable to compensate for concussion deficits
Discharge instructions

• Usually self-limited with a natural history of recovery occurring within several weeks following injury.
• 5%–15% of persons have persistent symptoms; therefore, instructions should include to follow up with their healthcare provider if their symptoms do not improve by 1 week after their injury.
Management

• Concept of brain rest has be balanced with academic demands of school
• Since symptoms usually worsen with the increased cognitive strain of school returning to school is not recommended until symptoms are mild to absent at rest
Cognitive and physical reintegration are similar

- Needs to be asymptomatic before exertion
- Return to baseline neuropsych test
- Graded return to play
  - Asymptomatic at rest
  - No symptoms when running
  - No symptoms - noncontact drills
  - No symptoms - contact drills
  - No symptoms - during game
Summary

- Concussion is a clinical diagnosis
- Key to management is education of the patient and their family
- Encourage cognitive and physical rest to speed recovery