Sports-Related Concussion Management:
A comprehensive approach for return to social, academic, and athletic activity

Scott Gonzalez
Matt Hjertstedt
Objectives

- Define Concussion
- Understand the appropriate use of diagnostic testing
- Understand the many issues that a concussion can have on a student
- Recognize possible treatment and management strategies
In the Media

- Concussion Study in Young Players
  - Posted by Rebecca Black on October 30th, 2010

- Tackling helmet safety head on: Some football helmets are better than others when it comes to preventing concussions
  - May 10, 2011 | By Karen Kiley | Reporter

- Hockey Canada taking serious look at head shots
  - By Rita Mingo, Postmedia News May 27, 2011

- The Death of Wouter Weylandt: Tragedy Strikes the Giro D'Italia
  - By Ian Doward: Featured Columnist) on May 9, 2011

- Footy Concussion Report Round 10
  - Posted by Dustin Fink on May 26, 2011
Questions to IBSC Members

- Is this the “newest hot topic”? Several years ago it was steroids.
- Is this a way to target popular sports that some see as too aggressive and violent?
- Is this partially driven by equipment companies who wish to create more products?
- How prevalent do you think this issue is in your school?
Concussion Identification

- Which athlete has an orthopedic injury?

A

B
Concussion Identification

- Which athlete needs stitches?

C  D
Concussion Identification

- Which athlete has a concussion?
Concussion Identification

- Concussions can be a “hidden injury.”
- In the past, we could only trust athletes to report symptoms.
- Is there a way to objectively measure the injury outside of the acute symptoms?
Incidence

- United States
  - 1.5 million Americans sustain TBI each year
  - 75% are MTBI
  - 1 Million TBI treated in emergency department each year
  - MTBI’s cost $17 Billion USD year

- UNITED KINGDOM
  - 700,000 visit Emergency Room each year
  - 90% Minor
  - In the UK, 40-50% of people with head injuries are children
    - Children treated each year with MTBI = 315,000
Definition of Concussion

- The word originates in the Latin stem of *concutere*, to dash together or to shake violently.

- Early Definition: 1942 - Concussion results in momentary LOC, mild confusion and automatism with amnesia with complete recovery within a few days.

*Concussion: The history of clinical & pathophysiological concepts and misconceptions*  
McCrory & Berkovic
The Evolving Definition of Concussion

- A concussion (or mild traumatic brain injury) is a complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces secondary to direct or indirect forces to the head. Disturbance of brain function is related to neurometabolic dysfunction, rather than structural brain injury, and is typically associated with normal structural imaging findings (CT Scan, MRI). Concussion may or may not involve a loss of consciousness. Concussion results in a constellation of physical, cognitive, emotional, and sleep-related symptoms. Symptoms may last from several minutes to days, weeks, months, or even longer in some cases.”

*CDC Physicians Toolkit; 2006*
Mechanism of Injury
Neurometabolic Cascade Following Cerebral Concussion

(Giza & Hovda, 2001)
Academic Activity

- Concussion on Academics
  - Difficulty learning new concepts
  - Difficulty in taking notes (vestibular function)
  - Difficult with recall of previously learned materials
- Academics affect on concussion
  - Increased Symptoms
  - Post Concussion Syndrome
  - Delays healing by increasing the energy needs
Social Activity

- Concussion on Social Activity
  - Mood and emotional changes
  - Social isolation
- Social Activity on Concussion
  - Increased symptoms with social activity
  - Increased workload on brain
  - Sensitivity to noise and light
  - Post Concussion Syndrome
Athletic Activity

- Concussion on Physical Activity
  - Isolation
  - Removed from sport
- Athletic Activity on Concussion
  - Increased symptoms during activity
- Danger Zone
  - Cumulative effects of concussion
  - Post Concussion Syndrome
  - Second Impact Syndrome
Second Impact Syndrome
PBS Video Frontline

- Football High: Bigger and Faster, But Safer?
  - [http://video.pbs.org/video/1880045332](http://video.pbs.org/video/1880045332)
Why do we have a Concussion Management Plan?

- Concussions affect many areas of student life
- There is a significant number of MTBI each year
- Improper management can lead to serious consequences: physical, academic, and social
- Medical community is trying to catch up with the large amount of research
Concussion Management Plan

- Needs to provide guidance to your medical team
  - Needs to include a physician
- Each concussion is different
  - Should use an individualistic approach
- Should be a team based approach
  - Communication is key
OVERVIEW

- All students years 7-12 required to have a baseline neuropsychological test
- No Homework on night of suspected injury
- No school the next day
- Post-injury ImPACT test 48-72 hours
- Appointment with a physician
  - Sets academic accommodations
- A student with a suspected concussion cannot return to physical activity until he has clearance from a physician and is symptom-free with rest and exertion.
Concussion Management Goals

Areas of focus

- Sideline (Acute) Management
  - Identify a concussion
  - Rule out intracranial pathology
    - Emergency Room Referral
      - CT or MRI
- Post Injury Management
  - Prevent Academic Difficulty / Stress
  - Prevent Post Concussion Syndrome
  - Prevent Cumulative Affect of Injury
  - Prevent Second Impact Syndrome
Acute Management

• Goals
  • Identify possible concussion
    • Use standardized concussion evaluation
      • SCAT2
      • Sideline concussion card
      • Balance Error Scoring System (BESS)
  • Evaluate Cranial Nerves
  • Determine if a more serious injury is suspected
    • Cerebral Contusion
    • Malignant Brain Edema Syndrome
    • Epidural Hematoma
    • Subdural Hematoma
St. Mark’s School of Texas
Athletic Training
Concussion Home Instructions

Athlete ___________________________ Date of injury _____________ Sport ________________

Home phone ________________________ Parent/guardian name ______________________________

Your son has sustained a head injury while participating in __________________________. In some instances, the signs of a concussion do not become obvious until several hours or even days after the injury. Please be especially observant for the following signs and symptoms.

1. Headache (especially one that increases in intensity*)
2. Nausea and vomiting*
3. Difference in pupil size from right to left eye, dilated pupils*
4. Mental confusion/behavior changes
5. Dizziness
6. Memory loss
7. Ringing in the ears
8. Changes in gait or balance
9. Blurry or double vision*
10. Slurred speech*
11. Noticeable changes in the level of consciousness (difficulty awakening, or losing consciousness suddenly)*
12. Seizure activity*
13. Decreased or irregular pulse OR respiration*

* Seek medical attention at the nearest emergency department.

The best guideline is to note symptoms that worsen, and behaviors that seem to represent a change in your son. If you have any question or concern about the symptoms you are observing, contact your family physician for instructions, or seek medical attention at the closest emergency department. Otherwise, you can follow the instructions outlined below.

It is OK to:
- Use acetaminophen (Tylenol) for headaches
- Use ice pack on head & neck as needed for comfort
- Eat a light diet
- Go to sleep
- Rest (no strenuous activity or sports)

There is NO need to:
- Check eyes with a flashlight
- Wake up every hour
- Test reflexes
- Stay in bed

Do NOT:
- Drink alcohol
- Drive while symptomatic
- Exercise or lift weights
- Take ibuprofen, aspirin, naproxen or other non-steroidal anti-inflammatory medications
Why limit Social and Academic activity?

- Decreased blood flow to brain
- Decreased glucose available
- Symptoms get worse with exertion (math, note taking, stimulus)
Neuropsychological Testing

- Currently is the only objective way to identify a concussion.
- Has been used since the 1980’s, but online versions have made it accessible to the general public.
- Has been scientifically shown to be reliable and valid in over 100 peer-reviewed journal articles.
ImPACT Test

Lead

[Images of different test screens shown]
# ImPACT™ Clinical Report

**Organization:** St. Marks School of Texas  
**Age:** 15

**Date of Birth:** 10/07/1994  
**Height:** 65 inches

**Gender:** Male  
**Weight:** 130 lbs

**Handedness:** Left

**Native country/region:** United States  
**Native language:** English

**Second language:**  
**Years Speaking:**

---

**Years of education completed excluding kindergarten:** 8  
**Repeated one or more years of school:** No

**Received speech therapy:** No  
**Diagnosed learning disability:** No

**Attended special education classes:** No  
**Problems with ADD/hyperactivity:** No

**Current sport:** Basketball  
**Current level of participation:** High School

**Primary position/event/class:** point guard  
**Years of experience at this level:** 1

---

**Number of times diagnosed with a concussion (excluding current injury):** 1

**Concussions that resulted in loss of consciousness:** 0

**Concussions that resulted in confusion:** 0

**Concussions that resulted in difficulty remembering events that occurred immediately after injury:** 0

**Concussions that resulted in difficulty remembering events that occurred:** 0

**Total games missed as a result of all concussions combined:** 0

---

**Concussion history:**

<table>
<thead>
<tr>
<th>Treatment for headaches by physician:</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment for migraine headaches by physician:</td>
<td>No</td>
</tr>
<tr>
<td>Treatment for epilepsy/seizures:</td>
<td>No</td>
</tr>
<tr>
<td>History of brain surgery:</td>
<td>No</td>
</tr>
</tbody>
</table>

**History of meningitis:** No

**Treatment for substance/alcohol abuse:** No

**Treatment for psychiatric condition (depression, anxiety):** No

---

**Diagnosed with ** ADD/ADHD:**  
**Diagnosed with Autism:**

**Diagnosed with Dyslexia:**

**Strenuous exercise in the last 3 hours:**
## ImPACT™ Clinical Report

<table>
<thead>
<tr>
<th>Exam Type</th>
<th>Baseline</th>
<th>Post-Injury 1</th>
<th>Post-Injury 2</th>
<th>Post-Injury 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date Tested</td>
<td>11/11/2009</td>
<td>03/08/2010</td>
<td>03/17/2010</td>
<td>03/22/2010</td>
</tr>
<tr>
<td>Last Concussion</td>
<td>03/05/2010</td>
<td>03/05/2010</td>
<td>03/05/2010</td>
<td>03/05/2010</td>
</tr>
<tr>
<td>Exam Language</td>
<td>English</td>
<td>English</td>
<td>English</td>
<td>English</td>
</tr>
<tr>
<td>Test Version</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
</tr>
</tbody>
</table>

### Composite Scores

<table>
<thead>
<tr>
<th>Composite Score</th>
<th>Baseline</th>
<th>Post-Injury 1</th>
<th>Post-Injury 2</th>
<th>Post-Injury 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memory composite (verbal)</td>
<td>100</td>
<td>87</td>
<td>94</td>
<td>99</td>
</tr>
<tr>
<td>Memory composite (visual)</td>
<td>81</td>
<td>83</td>
<td>67</td>
<td>80</td>
</tr>
<tr>
<td>Visual motor speed composite</td>
<td>33.75</td>
<td>35.55</td>
<td>42.03</td>
<td>41.35</td>
</tr>
<tr>
<td>Reaction time composite</td>
<td>0.54</td>
<td>0.55</td>
<td>0.51</td>
<td>0.43</td>
</tr>
<tr>
<td>Impulse control composite</td>
<td>2</td>
<td>5</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Total Symptom Score</td>
<td>4</td>
<td>45</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### Cognitive Efficiency Index: 0.54 0.33 0.47 0.58

The Cognitive efficiency Index measures the interaction between accuracy (percentage correct) and speed (reaction time) in seconds on the Symbol Match test. This score was not developed to make return to play decisions but can be helpful in determining the extent to which the athlete tried to work very fast on symbol match (decreasing accuracy) or attempted to improve their accuracy by taking a more deliberate and slow approach (jeopardizing speed). The range of scores is from approximately zero to approximately .70 with a mean of .34. A higher score indicates that the athlete did well in both the speed and memory domains on the symbol match test. A low score (below .20) means that they performed poorly on both the speed and accuracy component. If this score is a negative number, the test taker performed very poorly on the reaction time component.

Scores in **bold RED** type exceed the Reliable Change Index (RCI) when compared to the baseline score. However, scores that do not exceed to RCI index may still be clinically significant. Percentile scores if available are listed in small type.

<table>
<thead>
<tr>
<th>Hours slept last night</th>
<th>5</th>
<th>8</th>
<th>8.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medication</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### ImPACT™ Clinical Report

#### Word Memory

<table>
<thead>
<tr>
<th></th>
<th>Hits (Immediate)</th>
<th>Correct Distractors (Immediate)</th>
<th>Learning % Correct</th>
<th>Hits (Delay)</th>
<th>Correct Distractors (Delay)</th>
<th>Delayed Memory % Correct</th>
<th>Total % Correct</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>100%</td>
<td>100%</td>
<td>96%</td>
<td>100%</td>
<td>100%</td>
<td>96%</td>
<td>100%</td>
</tr>
</tbody>
</table>

#### Design Memory

<table>
<thead>
<tr>
<th></th>
<th>Hits (Immediate)</th>
<th>Correct Distractors (Immediate)</th>
<th>Learning % Correct</th>
<th>Hits (Delay)</th>
<th>Correct Distractors (Delay)</th>
<th>Delayed Memory % Correct</th>
<th>Total % Correct</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>88%</td>
<td>88%</td>
<td>92%</td>
<td>100%</td>
<td>96%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

#### X's and O's

<table>
<thead>
<tr>
<th></th>
<th>Total Correct (Memory)</th>
<th>Total Correct (Interference)</th>
<th>Avg. Correct RT (Interference)</th>
<th>Total Incorrect (Interference)</th>
<th>Avg. Incorrect RT (Interference)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>9</td>
<td>10</td>
<td>1</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>114</td>
<td>114</td>
<td>0.52</td>
<td>2</td>
<td>0.5</td>
</tr>
</tbody>
</table>

#### Symbol Match

<table>
<thead>
<tr>
<th></th>
<th>Total Correct (Visible)</th>
<th>Avg. Correct RT (Visible)</th>
<th>Total Correct (Hidden)</th>
<th>Avg. Correct RT (Hidden)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>27</td>
<td>1.38</td>
<td>9</td>
<td>1.94</td>
</tr>
<tr>
<td></td>
<td>27</td>
<td>1.52</td>
<td>9</td>
<td>2.46</td>
</tr>
<tr>
<td></td>
<td>27</td>
<td>1.40</td>
<td>9</td>
<td>1.56</td>
</tr>
<tr>
<td></td>
<td>26</td>
<td>1.25</td>
<td>9</td>
<td>1.85</td>
</tr>
</tbody>
</table>

#### Color Match

<table>
<thead>
<tr>
<th></th>
<th>Total Correct</th>
<th>Avg. Correct RT</th>
<th>Total Commissions</th>
<th>Avg. Commissions RT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>9</td>
<td>0.64</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>0.65</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>0.62</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>0.49</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

#### Three Letters

<table>
<thead>
<tr>
<th></th>
<th>Total Sequence Correct</th>
<th>Total Letters Correct</th>
<th>Pct. of Total Letters Correct</th>
<th>Avg. Time to First Click</th>
<th>Avg. Counted</th>
<th>Avg. Counted Correctly</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>2.43</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>15</td>
<td>15</td>
<td>1.74</td>
<td>14.4</td>
<td>14.2</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>15</td>
<td>15</td>
<td>1.92</td>
<td>18</td>
<td>17.6</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>15</td>
<td>15</td>
<td>2.25</td>
<td>17.4</td>
<td>16.4</td>
</tr>
<tr>
<td>Symptom</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>---------------------------------</td>
<td>----</td>
<td>----</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>Headache</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Nausea</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Vomiting</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Balance Problems</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Dizziness</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Fatigue</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Trouble falling asleep</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Sleeping more than usual</td>
<td>0</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Sleeping less than usual</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Drowsiness</td>
<td>1</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Sensitivity to light</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Sensitivity to noise</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Irritability</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Sadness</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Nervousness</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Feeling more emotional</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Numbness or tingling</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Feeling slowed down</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Feeling mentally foggy</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Difficulty concentrating</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Difficulty remembering</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Visual problems</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>Total Symptom Score</strong></td>
<td><strong>4</strong></td>
<td><strong>45</strong></td>
<td><strong>0</strong></td>
<td><strong>0</strong></td>
<td><strong>0</strong></td>
<td></td>
</tr>
</tbody>
</table>
Social Modifications

- Limit cognitive activity
  - No school or social events
    - Cannot attend games or practices
  - No electronics
    - Computer, cell phones, TV, video games, music
  - Limit light
- Refrain from activity that makes symptoms worse
- When symptoms abate, return to social activities is acceptable
  - Avoid: concerts, loud events, light shows, or situations with a lot of stimulus
Academic Modifications

• Made on a case by case basis

• General rules:
  • Full rest until symptom free
  • Progress back to school
    • Half days
    • Scribe for note taking
  • Homework and assessments made up on individual basis and decided by teachers with input from heads of school, nurse, and academic advisor.
RTP Progression

Once a student has returned to full school days and is symptom free, he can begin the physical exertion phase.

- No activity – do not progress to step 2 until asymptomatic
- Light aerobic exercise – walking, stationary bike
- Sport-specific training (e.g., skating in hockey, running in soccer)
- Non-contact training drills
- Full-contact training
- Game play

Note: If the athlete experiences post-concussion symptoms during any phase, the athlete should drop back to the previous asymptomatic level and resume the progression after 24 hours.
ImPACT Test

- Tool that physicians can utilize in making return-to-play decisions
- Cornerstone of concussion management
- Does not substitute for a thorough clinical evaluation
Discussion