Concussion in Horse Racing

Setting the Pace

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Founding Director and Professor
University of Pittsburgh Sports Concussion Program (Retired)
Things That You Need To Know About Concussion

- All concussions are different
- Everyone recovers at own speed
- The worst thing you can do is have a second concussion when recovering from the first one.
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. Recovery is a sequential process and symptoms may last from several minutes to days, weeks, months, or even longer in some cases.

Center of Disease Control, 2007
What Does it Feel Like to Have a Concussion?

- “I have a bad headache”
- “Light hurts my eyes”
- “Everything sounds louder”
- “I can’t concentrate or remember things”
- “I feel like I am in slow motion”
- “My balance is off”
- “I feel nauseated”
- “I feel worse when I exercise”
- “My vision is messed up”
  - “Everything looks blurry”
  - “I see double”
Biomechanics of Concussion:

What Causes the Injury?
Forces Involved with Concussion

- **Force Vectors**
  - Newton’s 2nd Law (Force = Mass times Acceleration)

- **Linear (translational) force**
  - Compression and stretching of brain cells (neurons)

- **Rotational (angular) force**
  - Rotation of the head stretches neurons
Linear Injury

If forces are sufficient, brain cells are stretched or broken

Head stops suddenly, brain moves within skull
Rotational Injury

Hit from side causes rapid rotation of the head and rotation of the brain within the skull

Can also result in brain cells being damaged
Brain Function and Concussion: What Happens?
Brain cells stretch and chemicals are disrupted.

During injury, potassium ions ($K^+$) rush out of the cell...
The Brain Returns to Normal (in most cases)

After many days

Everyone Recovers at their Own Rate!!
New Technologies

- New devices to measure force
  - Helmet-based sensors
  - Mouth guard sensors
  - Ear piece sensors
  - Other wearable technologies

Very useful but never a substitute for diagnosis by healthcare professional
Management of Concussion:

Good Management Results in Better Outcome and Usually Faster Return to Sports
The Pittsburgh Steelers Program (1990’s)

- First program to monitor professional athletes
- Resulted in league wide programs in NFL/NHL/MLB
- Resulted in adoption by other sports/leagues/Colleges
- Led to development of ImPACT Program
- Currently over 8 million kids have been tested
The ImPACT Program

- Invented in the 1990’s to better manage concussion.
- Tests brain functions that are affected by concussion.
- Is designed to be used as part of a comprehensive concussion management program.
- Now used by NFL, NHL, MLB, NASCAR, Indy Racing, Motocross, WWE, MLS, thousands of colleges and High Schools and Jockeys Guild.
- Available in 14 languages including Spanish, French, Portuguese and almost all European languages.

- Over 8 million athletes tested.
Concussion Management

Pre-Season

Concussion

1-3 Days?

Return to Sports

ImPACT Baseline Testing

Remove from sport

- SCAT-II
- Balance
- Vestibular Testing

First Follow-Up

Evaluation
- ImPACT
- Balance
- Vestibular

Follow-up Testing as needed

- Back to baseline?
- Normal Vest/Balance
- No symptoms with exertion
<table>
<thead>
<tr>
<th>Typical Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Clinical Interview</strong></td>
</tr>
<tr>
<td><strong>Balance and Vestibular-Ocular (visual) Screening</strong></td>
</tr>
<tr>
<td><strong>ImPACT testing</strong></td>
</tr>
<tr>
<td><strong>Same day patient feedback</strong></td>
</tr>
<tr>
<td>- Severity of Injury?</td>
</tr>
<tr>
<td>- Prognosis for Recovery?</td>
</tr>
<tr>
<td>- Neuroimaging indicated?</td>
</tr>
<tr>
<td>- Referral to Other Doctors?</td>
</tr>
<tr>
<td>- Level/type of Physical Exertion Allowed?</td>
</tr>
<tr>
<td>- Level of Cognitive Exertion Allowed?</td>
</tr>
<tr>
<td>- Return to Sport?</td>
</tr>
<tr>
<td><strong>Communication to Athlete, Doctors and to staff</strong></td>
</tr>
</tbody>
</table>
Vestibular and Visual Processes

- Dizziness, Fogginess, Feeling detached
- Motion discomfort, Nausea
- Difficulty in busy visual environments
- Anxiety, nervousness, intolerance to busy places
- Blurred vision, Difficulty with Reading
Returning to Sport After Concussion:
Protecting Your Health
**Step 1: Light Aerobic Exercise**
The Goal: only to increase an athlete’s heart rate.
The Time: 5 to 10 minutes.
The Activities: exercise bike, walking, or light jogging.
Absolutely no weight lifting, jumping or hard running.

**Step 2: Moderate Exercise**
The Goal: limited body and head movement.
The Time: Reduced from typical routine
The Activities: moderate jogging, brief running, moderate-intensity stationary biking, and moderate-intensity weightlifting

**Step 3: Non-contact Exercise**
The Goal: more intense but non-contact
The Time: Close to Typical Routine
The Activities: running, high-intensity stationary biking, the player’s regular weightlifting routine, and non-contact sport-specific drills. This stage may add some cognitive component to practice in addition to the aerobic and movement components introduced in Steps 1 and 2.

**Step 4: Practice**
The Goal: Reintegrate in full contact practice activity.

**Step 5: Return to Sport**
The Goal: Return to competition
Pressure to Return to Sports: Can we rely on what the athlete is telling us?

Not Really

- Athletes should never diagnose their own injury.
- Studies suggest that up to 50% of athletes experience concussion symptoms per year but only 10 percent report having an injury.
- Returning to sport with too early is dangerous and can delay recovery.
“When it comes to concussion, I will say anything to get back on the field”

NFL Athlete
Ongoing Controversies

- How many is too many?
- When is there risk of long-term problems?
- What is the risk of *Chronic Traumatic Encephalopathy (CTE)*?
CTE-What Does it Mean?

Normal | Pro-Football | Boxing
A Lifespan Model of Understanding Concussion

Genetics?
- Migraine HX?
- LD/ADD?

Genetic Expression?
- Brain Development?
- Sports?

Bigger?
- Faster?
- Stronger?
- Injury HX?
- “Natural Selection”

CTE?
- Aging?
- Other Diseases?
- Alzheimer’s?
- Obesity?
- HTN/Stroke

Lovell, 1996
Focused Case Presentation:

How to Use ImPACT to Manage an Injury
Case Example: High School Quarterback

✓ 15 year old, Sophomore
  • Honors student, High Average standardized testing
  • No other medical history-no prior concussion
    • Strong migraine history in maternal family

✓ In retrospect, difficulties with concussion started on September 11, 2009

He suffered two concussions during season but only reported after season
# ImPACT™ Clinical Report

**High School Football QB**

<table>
<thead>
<tr>
<th>Exam Type</th>
<th>Baseline</th>
<th>Post-injury</th>
<th>Post-injury</th>
<th>Post-injury</th>
<th>Post-injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exam Language</td>
<td>English</td>
<td>English</td>
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<tr>
<td>Test Version</td>
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<td>4.5.805</td>
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</table>

## Composite Scores *

<table>
<thead>
<tr>
<th>Composite Score</th>
<th>Baseline</th>
<th>Post-injury</th>
<th>Post-injury</th>
<th>Post-injury</th>
<th>Post-injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memory composite (verbal)</td>
<td>91</td>
<td>68%</td>
<td>83</td>
<td><strong>77</strong></td>
<td>18%</td>
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<tr>
<td>Memory composite (visual)</td>
<td>89</td>
<td>80%</td>
<td><strong>73</strong></td>
<td>55</td>
<td>5%</td>
</tr>
<tr>
<td>Visual motor speed composite</td>
<td>46.58</td>
<td>95%</td>
<td><strong>29.05</strong></td>
<td><strong>29.05</strong></td>
<td>19%</td>
</tr>
<tr>
<td>Reaction time composite</td>
<td>0.49</td>
<td>90%</td>
<td><strong>0.78</strong></td>
<td><strong>0.76</strong></td>
<td>1%</td>
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<tr>
<td>Impulse control composite</td>
<td>4</td>
<td>45</td>
<td>9</td>
<td>2</td>
<td>1</td>
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<tr>
<td>Total Symptom Score</td>
<td>0</td>
<td><strong>17</strong></td>
<td><strong>18</strong></td>
<td>7</td>
<td>3</td>
</tr>
</tbody>
</table>

*Scores in bold type indicate scores that exceed the Reliable Change Index score (RCI) when compared to the baseline score. However, scores that do not exceed the RCI index may still be clinically significant. Percentile scores, if available, are listed in small type. Please consult your ImPACT User Manual for more details.

† Clinical composite score is available only for exams taken in ImPACT version 2.0 or later.
## Clinical Report

**Exam Type** | Baseline | Post-injury | Post-injury | Post-injury | Post-injury |
--- | --- | --- | --- | --- | --- |

### Symptom Inventory (at time of exam)

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Baseline</th>
<th>Post-injury</th>
<th>Post-injury</th>
<th>Post-injury</th>
<th>Post-injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Nausea</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Vomiting</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Balance Problems</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Dizziness</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Fatigue</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Trouble falling asleep</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Sleeping more than usual</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>0</td>
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<tr>
<td>Sleeping less than usual</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Drowsiness</td>
<td>0</td>
<td>2</td>
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<td>0</td>
<td>0</td>
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<tr>
<td>Sensitivity to light</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>0</td>
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<tr>
<td>Sensitivity to noise</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Irritability</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Sadness</td>
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<td>Nervousness</td>
<td>0</td>
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<td>0</td>
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<tr>
<td>Feeling more emotional</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Numbness or tingling</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Feeling slowed down</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Feeling mentally foggy</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Difficulty concentrating</td>
<td>0</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>2</td>
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<tr>
<td>Difficulty remembering</td>
<td>0</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Visual problems</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Total Symptom Score** | 0 | 17 | 18 | 7 | 3 |
Case Example: High School Quarterback

- Athlete had a “mild” injury but did not report it.
- Second injury made things worse
- He put himself at risk for permanent brain injury and required more treatment
- If he would have reported his first injury, he probably would have recovered in a week or two.
Case Example: High School Quarterback

- Initially hid symptoms from Athletic Trainer, coach and parents (told friends)
- Struggled in school and grades dropped
- Severe headaches, dizziness, cognitive problems
- Required vestibular therapy and medical management
- He risked permanent injury
Thank you!

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