Concussions: Diagnosis and Current Management

Christopher Tangen, D.O.
1-24-14
Introduction

• Definition
• History
• Diagnosis
• Management
• Return to play
• Controversies
Concussion - Definition

• Zurich Nov 2012:
• “a brain injury”
• “a complex pathophysiological process affecting the brain, induced by biomechanical forces”
Background

• Caused by:
  – “impulsive” forces transmitted to the head

• Symptoms:
  – typically rapid onset, or sx’s over minutes/hours

• Neuropathologic changes:
  – Functional but not structural injury
  – No abnormalities on current standard neuroimaging
Background

• Up to 3.8 million concussions/year in US

• 50% unreported

• Highest incidence in football
  – hockey, rugby, soccer, basketball, wrestling
Pathophysiology
Pathophysiology

• Metabolic changes in IC and EC environment
  – Inc Na/K ATPase activation
    • Hyperglycolosis
    • High energy demand

• Decreased cerebral blood flow
  – Widespread cerebral neurovascular constriction

• Resultant metabolic mismatch
History of Concussion Care

• Before 2001- “grading”
  – Mostly based on LOC (10%)

• 2001- 1st International Conference on Concussion in Sport- Vienna
  – Abandoned grading
  – established no RTP same day, and RTP protocol
History of Concussion Care

- 2004 - 2\textsuperscript{nd} International Conference - Prague
  - "Simple" vs "Complex" (length of sx's)
  - first SCAT card "Sport Concussion Assessment Tool"
The SCAT Card
(Sport Concussion Assessment Tool)
MEDICAL EVALUATION

Name: ___________________________ Date: ___________________________
Sport Team: ________________________ Mouth Guard: Y N

1) SIGNS
Was there loss of consciousness or unresponsiveness? Y N
Was there amnesia or amnesia activity? Y N
Was there a balance problem/dizziness? Y N

2) MEMORY
Alphabetical Memory Questions (Check those correct)
At what venue are we? ______ Which half is it? ______
Who scored last? ______ What team did we play last? ______
Did we win the last game? ______

3) SYMPTOM SCORE
Total number of positive symptoms (from “SYMPTOMS” box on other side of the card) ______

4) COGNITIVE ASSESSMENT
(Check those correct)
Immediate Delayed
Word 1: cat ______ ______
Word 2: pain ______ ______
Word 3: shoe ______ ______
Word 4: book ______ ______
Word 5: car ______ ______

Athletes in reverse order (circle those named):
June Aug Mar Feb Jan Dec Nov Oct Sep Aug Jul
OR
Digit backwards (check those correct):
5-2-8 ______ 3-6-1 ______
6-3-9-6 ______ 6-3-9-1 ______
8-3-7-6 ______ 1-4-3-8 ______
7-3-8-6-2 ______ 5-1-8-9-8 ______

Ask delayed 5-word recall now.

5) NEUROLOGICAL SCREENING
Pass Fail
Eye Motion and Pupil ______ ______
Peristaltic Drift ______ ______
Gait Assessment ______ ______
Any neurological screening abnormally necessitates formal neurologic or hospital assessment.

6) RETURN TO PLAY
ATHLETES SHOULD NOT RETURN TO PLAY THE SAME DAY OF INJURY.

When returning athletes to play, they should follow a stepwise symptom-focused program, with stages of progression. For example:
1. not exhibiting symptoms (physical and mental rest)
2. light exercise (e.g., stationary cycle)
3. sports-specific training
4. non-contact training drills (short light resistance training)
5. full contact training after medical clearance
6. return to competition (game play)

There should be approximately 24 hours (or longer) for each stage and the athlete should return to stage 1 if symptoms recur. Resistance training should only be added in the later stages.

Medical clearance should be given before return to play.

INSTRUCTIONS:
This card is for the use of medical doctors, physical therapists, athletic trainers, and other health professionals who are involved in the assessment and care of athletes following a concussion. It is strongly suggested that all athletes participating in contact sports complete a baseline evaluation prior to the beginning of their competitive season. This card is intended to be a guide for the assessment of concussive symptoms. It is not intended to assess for other forms of brain injury.

S meas: 

Memory:
Select 5 words (or as many you can). Avoid choosing related words such as “fish” and “fins” which can be recalled by means of word association. Each word should be at one word per second. The athlete should be informed of the delayed testing of memory to be done after the reverse order of the page.

Symptoms:
Headache, photophobia, “pressure in the head”, vivid梦, nausea, vomiting, blurred vision, inability to concentrate, dizziness, hearing problems, ringing in the ears, “don’t feel right”, “feel off”, confusion, feeling slowed down, feeling like a “log”, dizziness, fatigue, fatigue or low energy, emotional inappropriate, difficulty concentrating or remembering.

Concentration/Attention:
Ask the athlete to repeat the months of the year in reverse order starting with a minute break. Do not start with December or February. Can any months not recalled in the correct sequence?

For digits backwards, if correct, go to the next string length. If incorrect, test each digit. Stop after incorrect on both trials.

Neurologic Screening:
Trained medical personnel must administer this examination. These individuals might include medical doctors, physical therapists, or athletic trainers. Speech should be assessed for clarity and lack of slurring. Eye motion should be evaluated for difficulty in any of the 4 directions of movement (vertical, horizontal, and diagonal). The patient’s drift should be performed by asking the patient to hold both arms in front of them, palms up, with eyes closed. A positive test is producing the forearm, dropping the arm, or drift away from the examiner. For error assessment, ask the patient to walk away from you, turn and walk back.

Return to Play:
A structured, graded exertion protocol should be developed individually on the basis of sport, age and the concussion history of the athlete. Exercise or training should be commenced only after the athlete is clearly asymptomatic (no physical and cognitive test). Final decision for return to competition should ideally be made by a medical doctor.

History of Concussion Care

• 2008- 3rd International Conference- Zurich
  – Abandoned “Simple vs Complex”
  – RTP expanded
    • Adult athletes may RTP more quickly. Namely “American football” players
  – Objective balance testing added
    • “BESS” Balance Error Scoring System
  – Greater recognition to neurophyscologic testing
    • Did not consider NP testing the standard of care
  – Difference between adolescents and adults (briefly) acknowledged
Cognitive & Physical Evaluation

1. Symptom score (total score 22)
   22 minus number of symptoms

2. Physical signs score
   
<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>N</td>
<td>N</td>
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<tr>
<td>N</td>
<td>N</td>
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<td>N</td>
<td>N</td>
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<tr>
<td>N</td>
<td>N</td>
</tr>
</tbody>
</table>

3. Glasgow coma scale (GCS)
   
<table>
<thead>
<tr>
<th>Eye opening</th>
<th>Verbal response</th>
<th>Motor response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
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</tr>
<tr>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>

   GCS should be recorded for all athletes in case of subsequent deterioration.

4. Sideline Assessment – Maddocks Score
   
   - "I am going to ask you a few questions, please listen carefully and give your best effort."
   - "Am I right today?"
   - "What time is it right now?"
   - "What is the colour of the wall?
   - "What is the size of the room?"
   - "What is the colour of the clock?"
   - "What did you have for lunch?"
   - "What is your phone number?"

5. Cognitive assessment
   
   Standardized Assessment of Concussion (SAC)
   
<table>
<thead>
<tr>
<th>Task 1</th>
<th>Task 2</th>
<th>Task 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
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<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

   Immediate memory
   
   "I am going to test your memory. I will read you a list of words and when I am done, repeat back as many words as you can recall in any order."

   Task 1 & 2:
   
   "I am going to repeat the list of words again. Repeat back as many words as you can remember in any order, even if you say the words backwards."

   Task 3:
   
   "I am going to test your memory again. Repeat back as many words as you can remember in any order, even if you say the words backwards."

   Immediate memory score
   
   Concentration
   
   - Digit span forward: 3 digits
   - Digit span backward: 3 digits

   Concentration score
   
   This tool has been developed by a group of independent experts at the 3rd International Conference on Concussion in Sport, Prague 2004, British Journal of Sports Medicine, 2005; 39: 161-20.
History of Concussion Care

• 2012 - 4th International Conference- Zurich
  – Published March 2013
  – Recommended all athletes have a clinical neurological assessment (and cognitive function assessment)
  – But formal NP testing is NOT required for all athletes
    • “insufficient evidence to recommend the widespread routing use of baseline neuropsychological testing”
  – NO same day RTP
Concussion Diagnosis

• An athlete that shows any feature of a concussion
  – Immediate removal from practice/play
  – Urgent evaluation by a physician or other licensed healthcare provider (ex: athletic trainer)
  – Attention to C-spine
Concussion signs/symptoms

- Headache - most common
- “Pressure in head”, neck pain, n/v, dizziness, blurred vision, balance problems, sensitivity to light/noise, feeling slowed down, feeling like “in a fog”, “don’t feel right”, difficulty concentrating/remembering, fatigue or low energy, confusion, drowsiness, trouble falling asleep, more emotional, irritability, sadness, nervous or anxious
Different Clinical Presentations

- Concussions can manifest
  - Symptoms
    - Headache
  - Physical signs
    - LOC, amnesia
  - Behavioral changes
    - Mood changes
  - Cognitive impairment
    - School
  - Sleep disturbance
    - Insomnia
Other tools

• Imaging
• Neuropsychological testing
• Genetic testing
Imaging

- Likely in an emergency room setting
- Plain films, CT, MRI - no standard structural changes
- fMRI
Neuropsychological testing

• Common
  – Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT)
  – Automated Neuropsychological Assessment Metrics (ANAM)
  – Cogsport

• Neurologic and cognitive eval should be a part of preparticipation exam, but NP testing is not required/recommended for all athletes
Neurocognitive Assessment Branch (ANAM)

If your unit is deploying within the next 12 months and needs ANAM to please send an e-mail including all pertinent contact information to usarmy.jbsa.medcom.mbx.otsg-anam-operations@mail.mil for more in the ANAM Schedule at 210-916-9231.

There is a major focus on cognitive assessment for Service Members. The concussions seen during conflicts in which Service Members may be injured by explosions, also known as mild traumatic brain injury (mTBI).

A brain injury that may result from such blasts can range from mild to severe.

An mTBI/concussion may cause changes which include a slower reaction time, sleep difficulty. These symptoms may result in decreased performance. Performance of the ANAM
Neuropsychological testing

• Computerized NP testing
  – Administer pre-season before head injuries
  – If a concussion is suffered- wait until asymptomatic, retest, compare to baseline
  – Use retest results as adjunct to clinical picture
  – Most helpful in conjunction with NP consult, or in athletes with prolonged symptoms
  – No relationship between NP testing and school performance
**ImPACT Clinical Report**

<table>
<thead>
<tr>
<th>Exam Type</th>
<th>Baseline</th>
<th>Post-concussion</th>
<th>Post-concussion</th>
<th>Post-concussion</th>
<th>Post-concussion</th>
<th>Post-concussion</th>
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</thead>
<tbody>
<tr>
<td>Exam Language</td>
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<td>Test Version</td>
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<td>2.2.729</td>
<td>2.2.729</td>
<td>2.2.729</td>
</tr>
</tbody>
</table>

**Composite Scores**

<table>
<thead>
<tr>
<th>Composite</th>
<th>Baseline</th>
<th>Post-concussion</th>
<th>Post-concussion</th>
<th>Post-concussion</th>
<th>Post-concussion</th>
<th>Post-concussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memory composite (verbal)</td>
<td>93</td>
<td>75%</td>
<td><strong>66</strong></td>
<td>1%</td>
<td><strong>57</strong></td>
<td>1%</td>
</tr>
<tr>
<td>Memory composite (visual)†</td>
<td>70</td>
<td>23%</td>
<td><strong>41</strong></td>
<td>&lt;1%</td>
<td><strong>49</strong></td>
<td>1%</td>
</tr>
<tr>
<td>Visual motor speed composite</td>
<td>45.88</td>
<td>85%</td>
<td>46.38</td>
<td>86%</td>
<td><strong>40.13</strong></td>
<td>65%</td>
</tr>
<tr>
<td>Reaction time composite</td>
<td>0.54</td>
<td>46%</td>
<td>0.60</td>
<td>22%</td>
<td><strong>0.66</strong></td>
<td>6%</td>
</tr>
<tr>
<td>Impulse control composite</td>
<td>8</td>
<td>46%</td>
<td>14</td>
<td>22%</td>
<td>10</td>
<td>6%</td>
</tr>
<tr>
<td>Total Symptom Score</td>
<td>0</td>
<td>46%</td>
<td><strong>14</strong></td>
<td>22%</td>
<td>3</td>
<td>6%</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.
Genetic testing

• Not standard of care

• APOE e4 (apolipoprotein e4)
  – Study limitations- small sample sizes, use of self-reported concussions, lack of control groups
Management

• Cornerstone of treatment: REST
  – Cognitive and Physical

• Gradual RTP
Stepwise RTP

• Athlete must remain asymptomatic
  – Day 1- no activity
  – Day 2- light aerobic exercise
  – Day 3- sport-specific training
  – Day 4- non-contact training drills
  – Day 5- full-contact practice
  – Day 6- return to play
Return to play

• What if symptoms return?
  – Return to previous level?
  – Start over at day 0?
    • adolescents
Pharmacologic management

- No NSAIDs or aspirin after concussion
- Omega-3-FA
  - Prelim encouraging data in mice
- Targeting symptoms (ex: sleep)
- Or targeting underlying pathophys
  - Antidepressants
  - Experienced provider
Complications/controversies of concussions

- Second Impact Syndrome
- Decreased threshold
- Female gender
- Legislation
- Prevention
Second Impact Syndrome

- Rare - only found in adolescents
- Literature - case reports
  - Ongoing sx after 1\textsuperscript{st} concussion
  - Witnessed 2\textsuperscript{nd} event with rapid deterioration
  - Evidence of cerebral swelling - brain herniation - death
- Past 15 years - approx 100 cases reported
Decreased threshold

- Evidence suggests that a second blow before the brain recovers results in worsening metabolic changes within the cell.
- When premature activity (cognitive or physical) occurs before complete recovery- the brain may be vulnerable to prolonged dysfunction.
- Previous concussion assoc with higher risk of sustaining another concussion.
- Greater number/severity/duration of sx- predictors of prolonged recovery.
Female gender

• More reported symptoms than men
• Cognitive impairment 1.7x more common than men
• With similar rules - reported incidence is higher in females
• Estrogen and diff cerebral blood flow may influence severity and outcome
• Is female gender a risk factor? Merely a predictor of symptom reporting?
NFL

- Generated most policy changes
- 4300+ out of ~12000 players filed over 200 lawsuits ($765m ruling)
- Cannot lead with helmet; closer kickoffs
- Athletic trainer in game booth
- Sideline/locker room assessment by team doctors
- Independent neurologists
Legislation

• Zackery Lystedt
  – 2006 Washington State
  – Middle school football- head injury before 1st concussion healed
Lystedt Law

- Athletes, parents and coaches must be educated about the dangers of concussions each year.
- If a young athlete is suspected of having a concussion, he/she must be removed from a game or practice and not be permitted to return to play. When in doubt, sit them out.
- A licensed health care professional must clear the young athlete to return to play in the subsequent days or weeks.
Ohio House Bill 143

- Governor John Kasich signed youth concussion bill into law 12/20/12
- Parents need to sign letter showing understanding of this law
- Concussed athlete removed from sports
- Written clearance by physician or other licensed health care provider (in conjunction with a physician)
Prevention

- Education
- Helmets
- Mouth guards
- Neck strengthening
Summary

• Up to 3.8 million/year in US (underreported)
• No RTP same day
• Stepwise RTP
• NFL/Legislation
References


• Darling, S. et al. CJS M 2013: 0; 1-6. Evaluation of the Zurich Guidelines and Exercise Testing for Return to Play in Adolescents Following Concussion