Disclosure

• CIC for ImPACT Applications, Inc
• Listed on ImPACT website as a “concussion management professional” in the Tucson area
• I don’t sit on the ImPACT board and receive no remuneration, financial or otherwise
Objectives

- Recognize the signs and symptoms of concussion injuries
- Be familiar with modifying factors of concussion and their role in concussion presentation and management
- Be aware of role of vestibular and ocular systems in concussion presentation
- Be aware of treatment modalities in management of concussion
Sports concussions are complex injuries that present in a number of ways.

Long appreciated the need to exam cognitive function in concussed pt, balance assessment has been emphasized recently.

Includes vestibular and ocular motion.
Effects of Concussive Forces on the Brain

- Typically, the “software” of the brain is affected
  - Neurometabolic/neurochemical processes
  - Physiological
- Not the “hardware”
  - Structures appear normal with “traditional” imaging
Pathophysiology of Concussion

Neurometabolic Cascade of mTBI: Pathophysiology

- Cell Death
- Protease activation
- Energy Crisis
- Membrane damage & leakage
- Altered neurotransmission
- Glutamate
- Ionic flux
- K+ leakage
- ATP

Katayama, et al., J Neurosurg 1990
Giza and Hovda, J Neurosurg 2014

Courtesy of Chris Giza, UCLA
Pathophysiology of Concussion
Signs and Symptoms
Symptoms

- HA (71%)*
- Feeling slow (58%)*
- Concentration (57%)*
- Dizziness (55%)
- Foggy (53%)*
- Fatigue (50%) *
- Double/blurry vision (49%)
- Photophobia (47%)*
- Memory dysfunction (43%)*
- Balance (43%)*
- N/V
- Sluggish
- Change in sleep pattern
- Cognitive changes

*Lovell, Collins et al, 2004
## Concussion Symptoms By Category

<table>
<thead>
<tr>
<th>Somatic</th>
<th>Cognitive</th>
<th>Emotional</th>
<th>Sleep</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache</td>
<td>Difficulty thinking clearly</td>
<td>Irritability</td>
<td>Sleeping more than usual</td>
</tr>
<tr>
<td>Fuzzy or blurry vision</td>
<td>Feeling slowed down</td>
<td>Sadness</td>
<td>Sleeping less than usual</td>
</tr>
<tr>
<td>Dizziness</td>
<td>Difficulty concentrating</td>
<td>Feeling more emotional</td>
<td>Trouble falling asleep</td>
</tr>
<tr>
<td>Fatigue</td>
<td>Difficulty remembering new information</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drowsiness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitivity to light</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitivity to noise</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Balance problems</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nausea or vomiting (early on)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**SOURCE:** CDC, 2013.
EVALUATION
On-field Evaluation

• When a player shows **ANY** symptoms or signs of a concussion:
  • All head and neck injuries assess ABC’s (CABs)
    • Airway
    • Breathing
    • Circulation
  • C-spine (neck) eval (if unconscious, assume C-spine (neck) injury)
Sideline Evaluation

• Remove athlete from game/practice
• Let coach know athlete unavailable
• Primary goal is to rule out more serious injury
• Facial trauma (black eye, nasal fracture, broken or missing teeth)
  • Think possible concussion
• Ask about neck pain
Sideline evaluation of concussion

• Evaluation using SCAT-3, SAC, or other tool to assess extent of injury
• Standard orientation questions (eg, PPT) unreliable*
• Serial exams are important for the first two hours

*McCrea M et al Neurology 1997;48:586–8..
Sideline Evaluation

- Symptom inventory
- Memory
- Orientation
- Concentration
- Neurological examination
- Balance Coordination
- Can be done with SCAT3 or similar tool
## Sideline Evaluation

<table>
<thead>
<tr>
<th>Area</th>
<th>Evaluation Technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orientation</td>
<td>Venue, time of day and game, who scored last, opponent, city (not PPT, serial 7’s/3’s*)</td>
</tr>
<tr>
<td>Attention</td>
<td>Digits, MOY, DOW</td>
</tr>
<tr>
<td>RGA</td>
<td>Memory of hit, previous play, score prior to hit, plays of previous quarter, responsibilities</td>
</tr>
<tr>
<td>AGA</td>
<td>3 objects immediately and after 5 mins</td>
</tr>
<tr>
<td>Appearance</td>
<td>Dazed look, incoherent speech, balance problems, emotionality, behavior change</td>
</tr>
</tbody>
</table>

What is the SCAT3?

The SCAT3 is a standard tool for evaluating concussions in athletes. It is used to assess athletes aged 9 years and above. It is designed to be used by medical professionals. If you are not confident using the SCAT3, you may be helpful for interpreting post-concussion test scores.

Specific instructions for use of the SCAT3 are provided on page 1. If you are not familiar with the SCAT3, please read through these instructions carefully. This tool is designed for use by trained professionals and should be used in conjunction with other medical advice.

The diagnosis of concussion is a clinical judgment, ideally made by a medical professional. The SCAT3 should not be used to make a diagnosis of concussion; it may only be used as a tool to assist in making a diagnosis.

Potential signs of concussion:

If any of the following signs are observed after a direct or indirect blow to the head, the athlete should stop playing, be evaluated by a medical professional, and be permitted to return to sport only if a concussion is excluded.

Any loss of consciousness?

Yes

No

Balance/eye coordination?

Yes

No

Disorientation/confusion/ability to report same event is questioned

Yes

No

Amnesia?

Yes

No

Headache

Yes

No

Any other symptoms?

Yes

No

The athlete should be advised to visit a medical professional if they have any of the above symptoms.

Glasgow coma scale (GCS)

Eye opening response (E)

Nog

1

2

3

Eye opening to voice

2

3

4

Eye opening to pain

3

4

5

Motor response (M)

1

2

3

4

5

Glasgow coma score (GCS) = E + M + V

SIDELINE ASSESSMENT

Indications for Emergency Management

If any of the following signs are observed after a direct or indirect blow to the head, the athlete should stop playing. The athlete should be evaluated by a medical professional, and the athlete should be permitted to return to sport only if a concussion is excluded.

Glasgow coma score (GCS)

Eye opening response (E)

Nog

1

2

3

Eye opening to voice

2

3

4

Eye opening to pain

3

4

5

Motor response (M)

1

2

3

4

5

Glasgow coma score (GCS) = E + M + V

Madecows Score

If any athlete with a suspected concussion is still present, the athlete should be removed from play. Any athlete who is suspected of having a concussion (i.e., should not be left alone and should not drive a motor vehicle) should be allowed to do so to see a medical professional. The athlete should not be allowed to return to play or practice before being cleared by a medical professional.

Glasgow coma score (GCS) = E + M + V

Note: Mechanism of injury (i.e., how it happened)
**BACKGROUND**

<table>
<thead>
<tr>
<th>Name</th>
<th>Date</th>
<th>Examining Team</th>
<th>Sport Team Name</th>
<th>Sport Team Number</th>
<th>Sport Venue</th>
<th>Date of Injury</th>
<th>Age</th>
<th>Gender</th>
<th>Injury Location</th>
<th>Description</th>
<th>Duration (minutes)</th>
<th>Date of last visit</th>
</tr>
</thead>
</table>

**Cognitive & Physical Evaluation**

1. **Cognitive Assessment**
   - Standardized Assessment of Concussion (SAC)
   - Orientation: 1
   - Immediate Memory: 1

2. **Symptom Evaluation**
   - Headache: 0
   - Nausea: 0
   - Dizziness: 0
   - Blurred vision: 0
   - Memory problems: 0
   - Sensitivity to light: 0
   - Difficulty concentrating: 0
   - Difficulty remembering: 0
   - Fatigue: 0
   - Other: 0

3. **Neck Examination**
   - Range of motion: 0
   - Sensation: 0
   - Strength: 0

4. **Balance Examination**
   - Standardized Balance Error Scoring System (SBESS)
   - Eyes open: 0
   - Eyes closed: 0

5. **Coordination Examination**
   - Upper limb: 0
   - Lower limb: 0

6. **SAC Delayed Recall**
   - Dated post-event recall: 0
INSTRUCTIONS

Instructions throughout this SAE-12K are the instructions given to the subject by the examiner.

Symptom Scale

"You should know yourself. You are the person most likely to notice changes in your body."

To be considered not abnormal, a symptom is a situation where the symptom is a feeling or a change occurring after exercise, and should be reported to the examiner within 10 minutes post-exercise.

For symptom severity scale, all scores are in terms of time, maximum possible is 60 x 10 = 600.

SAC Table

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache</td>
<td>10</td>
</tr>
<tr>
<td>Nausea</td>
<td>20</td>
</tr>
<tr>
<td>Dizziness</td>
<td>30</td>
</tr>
<tr>
<td>Fatigue</td>
<td>40</td>
</tr>
<tr>
<td>Shortness of breath</td>
<td>50</td>
</tr>
</tbody>
</table>

Depth of the 30-second walk is rated by counting the errors, or deviations from the proper stance, due to the examiner. The examiner will begin counting from the time the subject is seen to be in an upright position. The maximum SAE-12K is up to 100 points for each score during this time.

Field test stability is assessed by taking the number of times the subject falls during the test, which is recorded as "stability".

Intrusion score is the number of times the subject intrudes into the examiner's workspace during the test.

Concentration

1. Turn your head to the left and right simultaneously.
2. Repeat the exercise, this time using both hands.

English breakdown

1. Turn your head to the left and right simultaneously.
2. Repeat the exercise, this time using both hands.

Ease up and slow down.

Use hand gestures to indicate how well the subject can follow the examiner's instructions.

Motor function

1. Turn your head to the left and right simultaneously.
2. Repeat the exercise, this time using both hands.

Mobility in response: Time to respond.

"Your test is the test of the year in your order, the walk and go, followed by the exam."

Coordinated reach

1. Reach out for the examiner's hand.
2. Repeat the exercise, this time using both hands.

Balance Examination

Modified Balance Error Scoring System (MBESS) testing.

The balance testing is based on a modified version of the balance error scoring system (BESS) of assessment and is considered for inclusion in this test. The test is given to each subject.

Rt stability 5 time left, 3 time right.

Weight shift 1 (left), 2 (right).

All subjects will be given a score of A for the test.

References & Footnotes

1. The test has been developed by a group of experts at the 4th International Conference on Evaluation in Sport held in Davos, Switzerland in November 2005. The test is a modification of the balance error scoring system (BESS) test.
2. The test is given to each subject.
3. The test is given to each subject.
4. The test is given to each subject.
5. The test is given to each subject.
6. The test is given to each subject.
7. The test is given to each subject.
8. The test is given to each subject.
### ATHLETE INFORMATION

Any athlete suspected of having a concussion should be removed from play and then seek medical evaluation.

#### Signs to watch for

- Patient could be seen the first 24–48 hours. The athlete should not be allowed to play and should be kept in a hospital or area where:
  - They have a headache that gets worse
  - Able to smell but can’t be awakened
  - Client recognises people or places
  - Have repeated vomiting
  - Behave usually or seem confused, are very irritable
  - Have severe pain in the back or neck movement
  - Continues to sleep
  - Are unable to see their feet when they turn their head

Remember, it is better to be safe.

Consult your doctor after a suspected concussion.

#### Return to play

Athletes should be allowed to return to their usual activities at the same rate of days.

When returning athletes to play, they should be medically cleared and then follow a stepwise supervised program, with stages of progression.

#### Example:

<table>
<thead>
<tr>
<th>Test Domain</th>
<th>Test Name</th>
<th>Date</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Medical clearance should be given before return to play.

### CONCUSSION INJURY ADVICE

To be given to the athlete monitoring the concussed athlete.

This patient has sustained an injury to the head. A careful medical examination has been conducted and no signs of any serious complications have been found. Recovery is a variable process, and the athlete will need careful monitoring for a further period by a responsible adult. Your treating physician will provide guidance as to this monitoring.

If you notice any change in behavior, mood, alertness, symptoms, headache, sensitivity, or sensitivity, please consult your doctor or the emergency department immediately.

#### Important points:

- Rest physically and mentally, including resting or playing sports until symptoms resolve and you are medically cleared.
- No alcohol.
- No prescription or non-prescription drugs without medical supervision.
- Speech.
- No driving vehicles.
- Do not take any medication or vitamins.
- Do not use any over-the-counter medication or vitamins.
- Do not use any sleep aid medically cleared.

Contact phone number

Patient's name

Date

Doctor

Physician
# SCAT-3

## Glasgow coma scale (GCS)

<table>
<thead>
<tr>
<th>Best eye response (E)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>No eye opening</td>
<td>1</td>
</tr>
<tr>
<td>Eye opening in response to pain</td>
<td>2</td>
</tr>
<tr>
<td>Eye opening to speech</td>
<td>3</td>
</tr>
<tr>
<td>Eyes opening spontaneously</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Best verbal response (V)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>No verbal response</td>
<td>1</td>
</tr>
<tr>
<td>Incomprehensible sounds</td>
<td>2</td>
</tr>
<tr>
<td>Inappropriate words</td>
<td>3</td>
</tr>
<tr>
<td>Confused</td>
<td>4</td>
</tr>
<tr>
<td>Oriented</td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Best motor response (M)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>No motor response</td>
<td>1</td>
</tr>
<tr>
<td>Extension to pain</td>
<td>2</td>
</tr>
<tr>
<td>Abnormal flexion to pain</td>
<td>3</td>
</tr>
<tr>
<td>Flexion/Withdrawal to pain</td>
<td>4</td>
</tr>
<tr>
<td>Localizes to pain</td>
<td>5</td>
</tr>
<tr>
<td>Obeyes commands</td>
<td>6</td>
</tr>
</tbody>
</table>

**Glasgow Coma score (E + V + M)**

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

“I am going to ask you a few questions, please listen carefully and give your best effort.”

Modified Maddocks questions (1 point for each correct answer)

<table>
<thead>
<tr>
<th>Question</th>
<th>0</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>What venue are we at today?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Which half is it now?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Who scored last in this match?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>What team did you play last week/game?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did your team win the last game?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Maddocks score**

Maddocks score is validated for sideline diagnosis of concussion only and is not used for serial testing.
### SCAT-3

#### How do you feel?

*You should score yourself on the following symptoms, based on how you feel now.*

<table>
<thead>
<tr>
<th>Symptom</th>
<th>none</th>
<th>mild</th>
<th>moderate</th>
<th>severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>&quot;Pressure in head&quot;</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Neck pain</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Nausea or vomiting</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Dizziness</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Blurred vision</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Balance problems</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Sensitivity to light</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Sensitivity to noise</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Feeling slowed down</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Feeling like &quot;in a fog&quot;</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>&quot;Don't feel right&quot;</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Difficulty concentrating</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Difficulty remembering</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Fatigue or low energy</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Confusion</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Drowsiness</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Trouble falling asleep</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>More emotional</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Irritability</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Sadness</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Nervous or Ansious</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

**Total number of symptoms (Maximum possible 22)**

**Symptom severity score (Maximum possible 182)**

- Do the symptoms get worse with physical activity? Y N
- Do the symptoms get worse with mental activity? Y N

**Overall rating:** If you know the athlete well prior to the injury, how different is the athlete acting compared to how they were usual self? Please circle one response:

<table>
<thead>
<tr>
<th>response</th>
</tr>
</thead>
<tbody>
<tr>
<td>no different</td>
</tr>
<tr>
<td>very different</td>
</tr>
<tr>
<td>unsure</td>
</tr>
<tr>
<td>N/A</td>
</tr>
</tbody>
</table>
**Cognitive assessment**

**Standardized Assessment of Concussion (SAC)**

### Orientation

1 point for each correct answer

<table>
<thead>
<tr>
<th>Question</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>What month is it?</td>
<td>1</td>
</tr>
<tr>
<td>What is the date today?</td>
<td>1</td>
</tr>
<tr>
<td>What is the day of the week?</td>
<td>1</td>
</tr>
<tr>
<td>What year is it?</td>
<td>1</td>
</tr>
<tr>
<td>What time is it right now? (within 1 hour)</td>
<td>1</td>
</tr>
</tbody>
</table>

Orientation score: 5/5

### Immediate memory

<table>
<thead>
<tr>
<th>List</th>
<th>Trial 1</th>
<th>Trial 2</th>
<th>Trial 3</th>
<th>Alternative word list</th>
</tr>
</thead>
<tbody>
<tr>
<td>elbow</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>candle, baby, finger</td>
</tr>
<tr>
<td>apple</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>paper, monkey, penny</td>
</tr>
<tr>
<td>carpet</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>sugar, perfume, blanket</td>
</tr>
<tr>
<td>saddle</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>sandwich, sunset, lemon</td>
</tr>
<tr>
<td>bubble</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>wagon, iron, insect</td>
</tr>
</tbody>
</table>

Total: 3/5

Immediate memory score total: 3/15

### Concentration: Digits Backward

<table>
<thead>
<tr>
<th>List</th>
<th>Trial 1</th>
<th>Alternative digit list</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-9-3</td>
<td>0</td>
<td>3-2-9</td>
</tr>
<tr>
<td>3-8-1-4</td>
<td>0</td>
<td>3-2-1-6</td>
</tr>
<tr>
<td>6-2-9-7-1</td>
<td>0</td>
<td>1-5-2-9-7</td>
</tr>
<tr>
<td>7-1-8-4-6-2</td>
<td>0</td>
<td>5-3-9-1-4-8</td>
</tr>
</tbody>
</table>

Total of 4: 5/5

### Concentration: Month in Reverse Order

1 pt. for entire sequence correct


Concentration score: 5/5
### Neck Examination:
- Range of motion
- Tenderness
- Upper and lower limb sensation & strength

**Findings:**

### Balance Examination
Do one or both of the following tests.
- Footwear (shoes, barefoot, braces, tape, etc.)
- Modified Balance Error Scoring System (BESS) testing
  - Which foot was tested (i.e., which is the non-dominant foot)
    - Left
    - Right
  - Testing surface (hard floor, field, etc.)
- **Condition**
  - Double leg stance:
  - Single leg stance (non-dominant foot):
  - Tandem stance (non-dominant foot at back):
- **And/or**
  - Tandem gait:
    - Time (best of 4 trials): _______ seconds

### Coordination Examination
**Upper limb coordination**
- Which arm was tested:
- **Coordination score**
  - _______ of 1

### SAC Delayed Recall
**Delayed recall score**
  - _______ of 5
Vestibular-Ocular Screening
Horizontal and Vertical Saccades

Near Point Convergence
Vestibular-Ocular Reflex

Visual Motor Sensitivity (VMS)


In-Office Evaluation
Challenges

- Injured athletes may not be honest with their sx$s.
- Athletes are often addicted to their sport.

What’s helpful

- Ask others (parents, friends, SOs, teammates, roommates).
### CONCUSSION SYMPTOM SHEET

**NAME:**  
**I.D. #:**  
**DATE:**  

<table>
<thead>
<tr>
<th>SYMPTOMS</th>
<th>SCORE: 0 = No Symptoms; 1 = Minor; 6 = Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache</td>
<td>0 1 2 3 4 5 6</td>
</tr>
<tr>
<td>Nausea</td>
<td>0 1 2 3 4 5 6</td>
</tr>
<tr>
<td>Vomiting</td>
<td>0 1 2 3 4 5 6</td>
</tr>
<tr>
<td>Balance Problems</td>
<td>0 1 2 3 4 5 6</td>
</tr>
<tr>
<td>Dizziness</td>
<td>0 1 2 3 4 5 6</td>
</tr>
<tr>
<td>Fatigue</td>
<td>0 1 2 3 4 5 6</td>
</tr>
<tr>
<td>Trouble falling asleep</td>
<td>0 1 2 3 4 5 6</td>
</tr>
<tr>
<td>Sleeping more than usual</td>
<td>0 1 2 3 4 5 6</td>
</tr>
<tr>
<td>Sleeping less than usual</td>
<td>0 1 2 3 4 5 6</td>
</tr>
<tr>
<td>Drowsiness</td>
<td>0 1 2 3 4 5 6</td>
</tr>
<tr>
<td>Sensitivity to light</td>
<td>0 1 2 3 4 5 6</td>
</tr>
<tr>
<td>Sensitivity to Noise</td>
<td>0 1 2 3 4 5 6</td>
</tr>
<tr>
<td>Irritability</td>
<td>0 1 2 3 4 5 6</td>
</tr>
<tr>
<td>Sadness</td>
<td>0 1 2 3 4 5 6</td>
</tr>
<tr>
<td>Nervousness</td>
<td>0 1 2 3 4 5 6</td>
</tr>
<tr>
<td>Feeling more emotional</td>
<td>0 1 2 3 4 5 6</td>
</tr>
<tr>
<td>Numbness or tingling</td>
<td>0 1 2 3 4 5 6</td>
</tr>
<tr>
<td>Feelings slowed down</td>
<td>0 1 2 3 4 5 6</td>
</tr>
<tr>
<td>Feeling mentally foggy</td>
<td>0 1 2 3 4 5 6</td>
</tr>
<tr>
<td>Difficulty concentrating</td>
<td>0 1 2 3 4 5 6</td>
</tr>
<tr>
<td>Difficulty remembering</td>
<td>0 1 2 3 4 5 6</td>
</tr>
<tr>
<td>Visual problems such as double vision, blurring, etc</td>
<td>0 1 2 3 4 5 6</td>
</tr>
</tbody>
</table>

**COMMENTS:**
Vestibular System

• Subjective Complaints of Vestibular Dysfunction
  • Dizziness
  • Foggy
  • “One step behind”
  • Nausea
  • Overwhelmed in high stimulus area
Ocular Symptoms

- Frontal pressure in the head /behind eyes when reading/computer work/taking notes in class
- Have blurred or fuzzy vision while reading or difficulty reading
- Difficulties with “focus” or trouble with adjusting your eyes from near to far vision
- Symptoms worse during the school week versus the weekend
- Excessively tired at the end of a school day
- Difficulty with visual-based classes
NP testing can be a very useful
Full cognitive recovery should occur before RTP
Symptoms usually resolve before NP testing normalizes
Zurich guidelines NP testing is not required; however, several investigators have proposed that baseline NP testing be obtained in all athletes participating in contact sports as part of their preparticipation assessment.

This testing may be very helpful in the case of subsequent concussions, in that it can be used to assist with the timing of RTP.

Before an athlete becomes clinically asymptomatic, NP testing may be used to evaluate for deficits initially after injury, and may be useful in assisting with return to school issues and guidelines for teachers.
An athlete has a 45 second episode of loss of consciousness after heading another person’s head during a soccer match. No PTA, HA, dizziness or other S/S of a concussion. She now feels fine and has a normal examination. How would you grade the severity?

- Grade 1
- Grade 2
- Grade 3
- Need more information to answer the question
- Can’t answer the question as it’s worded
Concussion Grading Scales

- Over 25 scales
- None based on outcome or objective data
- Most scales assign worst prognosis to those with LOC
## Concussion Grading Scales

<table>
<thead>
<tr>
<th>Rugby football league (UK)</th>
<th>Federation Internationale de Ski (FIS)</th>
<th>Amateur Boxing Association</th>
<th>Auto Cycle Union (UK)</th>
<th>The Jockey Club (UK)</th>
<th>Rugby Union (Aust)</th>
<th>Rugby League (Australia)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mild</strong></td>
<td>No LOC</td>
<td>Transient concussion</td>
<td>Immediate recovery</td>
<td>LOC &lt;5 mins</td>
<td>No LOC</td>
<td><strong>Grade 0</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No LOC, confusion and disorientation, double vision, giddiness, unsteadiness</td>
<td></td>
</tr>
<tr>
<td><strong>Mod</strong></td>
<td>LOC &lt;2 mins</td>
<td>LOC &lt;60 secs</td>
<td>Complete recovery within 2 mins</td>
<td>LOC 5–60 mins</td>
<td>LOC &lt;60 secs or any degree of PTA or if rider sent to hospital</td>
<td><strong>Grade 1</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>LOC &lt;4 mins, vomiting</td>
<td></td>
</tr>
<tr>
<td><strong>Severe</strong></td>
<td>LOC &gt;2 mins</td>
<td>LOC &gt;60 secs</td>
<td>Complete recovery delayed for &gt;2 mins</td>
<td>LOC &gt;60 mins</td>
<td>LOC &gt;60 secs</td>
<td><strong>Grade 2</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>LOC &gt;4 mins</td>
<td>No LOC, cloudy sensorium &gt;1 min, headache, may have amnesia, tinnitus, or dizziness</td>
</tr>
</tbody>
</table>

**Grade 3**
- LOC <1 minute, not comatose, Grade 2 symptoms during recovery

**Grade 4**
- LOC >1 minute, not comatose, Grade 2 symptoms during recovery

LOC, loss of consciousness; PTA, posttraumatic amnesia.
TREATMENT
Cognitive as well as physical rest is important.

Cognitive rest important in pediatrics.

Many clinicians recommend “cocoon therapy” which may worsen treatment.

24-48 hours of cognitive rest is reasonable.

No evidence-based data on optimal rest period.


^ McCrory P, et al 2013
Strict rest for five days no more beneficial than up to 48 hours of rest

No clinically significant difference in neurocognitive or balance outcomes

Intervention group had more daily postconcussive sx(s) (over 10 days and slower symptom resolution)
Rest

• Advise pt in advance what to expect (they may get BORED!!!)
• Goal is to lessen imbalance between energy availability and energy needs
  • Restrict video games
  • Consider limiting computer use
  • Don’t restrict all social media (Facebook, texting, phone)
  • Restrict time in movies, mall, sporting events, and other high stimulation environments
Rest

• Accommodations
  • School absence when necessary
  • Also consider having the athlete **not** attend hardest classes initially
  • Initially attend ¼ day, then ½ day and then titrate up to full day
  • Breaks and extra time for homework
  • Extended time for assignments or tests
  • Work modifications if not able to completely take time off
  • Imperative to monitor physical activity
• Activities increase BP, pulse and temp (difficulty with regulation)
  • Can I go to Spring Fling/Disneyland/Magic Mountain?
  • Can I ride my bike to school and around campus?
  • Can I “celebrate” my birthday?
  • Can I “interact” with my GF/BF?
• Include ADL’s in physical exertion recommendations
  • Laundry, vacuuming, cleaning house, etc
• Challenges
  • Circadian rhythm is disrupted after concussion
  • Sleep disturbances in 42-70% concussed athletes
  • Pain from other injuries can also impair quality/quantity of sleep

*Jaffee M et al Brain Inj, 2015; 29(2): 221–227
Sleep

• What is helpful
  • Sleep hygiene
    • Comfortable room temp (temp regulation often impaired)
    • Avoid stimulation immediately before bedtime
    • Go to bed/get up at same time
  • Try to avoid sleepers in acute phase
    • Re-evaluate if insomnia becomes a chronic problem
  • Remain on a schedule even if not participating in activities
  • Monitor use of all meds/supplements, MJ, herbals, kava, etc
Medical Therapies for Concussion

- Sleep (use after discussing sleep hygiene)
  - Antihistamines
  - Melatonin
  - Trazodone
  - Ambien
  - Benzos (negative effects on arousal and cognition)

- Somatic (HA)
  - OTCs- (caution- rebound HA)
  - Amitriptyline (good for tension- and migraine-type HA)
  - Topamax
  - BF, PT, trigger point injections, psychotherapy
Medical Therapies for Concussion- (Con’t)

• Emotional
  • Coping strategies, psychotherapy
  • Amitriptyline
  • Sertraline and other SSRIs

• Cognitive
  • Cognitive rehab for severe, prolonged sx$s$
  • Methylphenidate
  • Amantidine
Role of Nutrition
Omega-3 fatty acids can help recover from a concussion

- True
- False
# Some Nutrients That Affect Cognition After Injury

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Effects</th>
<th>Food sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Omega-3 fatty acids (e.g. docosa-hexaenoic acid–DHA)</td>
<td>Improves cognition for ext TBI &amp; ext Alzheimers; reduces cognitive decline in human aging</td>
<td>Fish, flaxseed, krill, kiwi fruit, walnuts</td>
</tr>
<tr>
<td>Ketones</td>
<td>Improves cognition for ext TBI; reduces seizures in human epilepsy</td>
<td>Ketogenic diet/supplements; Atkins diet</td>
</tr>
<tr>
<td>Lactate, pyruvate</td>
<td>Improves cognition for ext TBI</td>
<td>Intravenous infusion</td>
</tr>
<tr>
<td>Curcumin</td>
<td>Improves cognition for ext TBI &amp; ext Alzheimers</td>
<td>Turmeric (curry spice)</td>
</tr>
<tr>
<td>Saturated fat</td>
<td>Worsens cognition for ext TBI &amp; human aging</td>
<td>Butter, suet, lard, coconut oil, cottonseed oil, dairy, meat</td>
</tr>
<tr>
<td>Vitamin E</td>
<td>Improves cognition for ext TBI; reduces cognitive decline in human aging</td>
<td>Asparagus, avocado, nuts, peanuts, olives, spinach</td>
</tr>
<tr>
<td>Choline</td>
<td>Improves cognition for ext seizures; may be related to human cognitive function</td>
<td>Egg yolks, chicken, veal, turkey, liver, lettuce</td>
</tr>
</tbody>
</table>

*Modified from Gomez-Pinilla F, Nature Rev Neurosci 2008*

Courtesy of Chris Giza, UCLA
Omega 3 Fatty Acids

• Good rat data
  • Less membrane damage (Mills et al J Neurosurg 2010)
  • ↓ oxidative stress after TBI (Wu A et al J Neurotrauma 2004)
  • ↓ axonal damage after concussion (Mills JD et al N Neurosurg 2010 and Bailes and Mills J Neurotrauma 2010)

• Need good human studies
Omega 3 Fatty Acids

• Less membrane damage (Mills et al J Neurosurg 2010)
• ↓oxidative stress after TBI (Wu A et al J Neurotrauma 2004)
• ↓axonal damage after concussion (Mills JD et al N Neurosurg 2010 and Bailes and Mills J Neurotrauma 2010)

• ....” The evidence is convincing that, if one had a pet rat and a book fell on its head, one should give it fish oil. The evidence is missing for humans. Therefore, although 6-3 PUFA seems safe and generally well tolerated and the potential benefit seems to be greater than the risk of taking fish oil, caution should be used in prescribing fish oil. Further work is needed to determine whether the use of 6-3 PUFA in humans, in particular DHA and EPA, produces clinically measurable benefits after concussion.”
  • Trojan T, Jackson E Curr Sp Med Rep 2011;10(4)180-185
Vestibular

- Non-pharmacological
  - Vestibular PT
- Pharmacological
  - Tricyclics if also has migraines
  - SSRI’s if mood disorder
Ocular

• Treatment
  • Neuro-ophthalmologist
  • Prisms and other lenses rx’ed by vision therapy specialist
  • Vestibular therapist
  • Audiobooks
  • Note-taking services
  • Computer breaks (occupational and academic)
Factors That Determine the Length of Rest Period Before Progression

• How long did symptoms last?
• What were symptoms at time of injury?
• What were symptoms that persisted?
• Previous history of concussion
• Age of patient
• Confidence patient is being honest
• Risk of activity
Factors That Determine the Length of Rest Period Before Progression

• Non-medical factors
  • Season vs off-season
  • When is next competition
  • Ability to allow to practice without contact
  • “Necessity” to practice to be able to play
    • Many of these factors allow you to be more conservative
• SAM/D
• SAD/M

^ Not evidence-based!
Graduated RTP Protocol

<table>
<thead>
<tr>
<th>Rehabilitation stage</th>
<th>Functional exercise at each stage of rehabilitation</th>
<th>Objective of each stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. No activity</td>
<td>Symptom limited physical and cognitive rest</td>
<td>Recovery</td>
</tr>
<tr>
<td>2. Light aerobic exercise</td>
<td>Walking, swimming or stationary cycling keeping intensity &lt;70% maximum permitted heart rate No resistance training</td>
<td>Increase HR</td>
</tr>
<tr>
<td>3. Sport-specific exercise</td>
<td>Skating drills in ice hockey, running drills in soccer. No head impact activities</td>
<td>Add movement</td>
</tr>
<tr>
<td>4. Non-contact training drills</td>
<td>Progression to more complex training drills, eg, passing drills in football and ice hockey May start progressive resistance training</td>
<td>Exercise, coordination and cognitive load</td>
</tr>
<tr>
<td>5. Full-contact practice</td>
<td>Following medical clearance participate in normal training activities</td>
<td>Restore confidence and assess functional skills by coaching staff</td>
</tr>
<tr>
<td>6. Return to play</td>
<td>Normal game play</td>
<td></td>
</tr>
</tbody>
</table>

Same day return to play
MODIFIERS
# Concussion Modifiers

<table>
<thead>
<tr>
<th>Factors</th>
<th>Modifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symptoms</td>
<td>Number</td>
</tr>
<tr>
<td></td>
<td>Duration (&gt;10 days)</td>
</tr>
<tr>
<td></td>
<td>Severity</td>
</tr>
<tr>
<td>Signs</td>
<td>Prolonged loss of consciousness (LOC) (&gt;1 min), Amnesia</td>
</tr>
<tr>
<td>Sequelae</td>
<td>Concussive convulsions</td>
</tr>
<tr>
<td>Temporal</td>
<td>Frequency—repeated concussions over time</td>
</tr>
<tr>
<td></td>
<td>Timing—Injuries close together in time</td>
</tr>
<tr>
<td></td>
<td>'Recency’—recent concussion or traumatic brain injury (TBI)</td>
</tr>
<tr>
<td>Threshold</td>
<td>Repeated concussions occurring with progressively less impact force or slower recovery after each successive concussion</td>
</tr>
<tr>
<td>Age</td>
<td>Child and adolescent (&lt;18 years old)</td>
</tr>
<tr>
<td>Comorbidities and premorbidities</td>
<td>Migraine, depression or other mental health disorders, attention deficit hyperactivity disorder (ADHD), learning disabilities (LD), sleep disorders</td>
</tr>
<tr>
<td>Medication</td>
<td>Psychoactive drugs, anticoagulants</td>
</tr>
<tr>
<td>Behaviour</td>
<td>Dangerous style of play</td>
</tr>
<tr>
<td>Sport</td>
<td>High-risk activity, contact and collision sport, high sporting level</td>
</tr>
</tbody>
</table>

Modifiers*

• Symptoms (Prolonged LOC, dizziness)
• Signs
• Temporal
• Threshold
• Age
• Comorbidities (Migraines, Depression/anxiety, ADHD)
• Gender
• SAM/D^  
• SAD/M^  

^Personal Experience, not evidenced-based!
Children should be managed more conservatively
- RTL prior to RTP
- Slower progression back to sports
- Kids still developing cognitively
- Not completely myelinated neurons
- Frontal lobes don’t mature until 20s
- Immature brain more sensitive to effects of glutamine
- More prolonged cerebral swelling
Questions

• Soccer head gear (such as Full 90) helps prevent concussions
  • True
  • False

• A custom mouth piece (as opposed to the “boil-and bite”) does not decrease one’s risk of concussions
  • True
  • False

• Improving neck strength and mass will decrease risk of a concussion
  • True
  • False
Mouthguards

• No help in concussion prevention or in reducing neurocognitive deficits
Condylar Position with Mouthguards

### Do Protective Devices Work?

<table>
<thead>
<tr>
<th>SPORT</th>
<th>EQUIPMENT</th>
<th>EFFECTIVE</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Football</td>
<td>CMO</td>
<td>No</td>
<td>Facial/Dental</td>
</tr>
<tr>
<td>Rugby</td>
<td>Mouthguard</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Rugby</td>
<td>Headgear</td>
<td>Inconclusive</td>
<td></td>
</tr>
<tr>
<td>Soccer</td>
<td>Headgear</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Field Hockey</td>
<td>Faceshield</td>
<td>Inconclusive</td>
<td>Facial/Dental</td>
</tr>
<tr>
<td>Ice Hockey</td>
<td>Faceshield</td>
<td>No</td>
<td>Faster RTP</td>
</tr>
<tr>
<td>Alpine Sports</td>
<td>Helmets</td>
<td>No evidence</td>
<td>Head injuries</td>
</tr>
<tr>
<td>Bicycle/Motor/</td>
<td>Helmets</td>
<td>No</td>
<td>Head injuries</td>
</tr>
<tr>
<td>Equestrian</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


COMPLICATIONS
Complications

• Post concussion syndrome
  • Personality changes (irritable, aggressive)
  • Deficits in short-term memory and problem solving
  • Chronic headaches
  • Sleep difficulties
  • Anxiety and depression
Complications

• Second Impact Syndrome
  • Injury to person who is still recovering from a previous concussion
  • Get brain swelling and death
  • Only occurs in adolescents
Complications

• Chronic Traumatic Encephalopathy
  • Progressive neurodegeneration clinically associated with memory disturbances
  • Behavioral and personality changes
  • Parkinsonism
  • Speech and gait abnormalities
Approximately a dozen lawsuits have been filed against the NFL claiming that the league and its doctors knew the long-term risks of concussions and failed to protect the players.

- **SETTLED!** – AUGUST, 2013

- **$765 Million**

- **REJECTED BY JUDGE!!!**

- **NOT ENOUGH $...**
NCAA LAWSUITS

- Two cases currently consolidated in the Northern District of Illinois seeking class action status
- *Arrington v. National Collegiate Athletic Association*
- NCAA has rejected these claims
- NCAA has a greater exposure than the NFL
- NCAA’s history with concussions is being questioned...
In Closing

- Concussions can be frustrating
- Present in different ways
- Have a good plan for sideline evaluation
- More active treatment than traditional
- Be conservative with any RTP decisions in an adolescent
In Closing

• See concussion patients on a weekly basis
  • How doing in school, assess needs for accommodations, meds, etc
• See concussion patients later in the day
• Know and utilize your athletic trainer
• Be specific in recommendations for progression back to activities
In Summary

• Interdisciplinary approach to the management of concussion:
  • Physician
  • ATC
  • Neurologist
  • Neuropsychologist
  • PT
  • Audiologist
  • Coach/AD/Teacher
  • Neuro-optometrist/ophthalmologist
  • Other specialists as needed
WHEN IN DOUBT, SIT THEM OUT!
(Even if they and the coaches/parents pout!)
If They Sway, They Do Not Play!
Where we’ve been.....
.....Where we are now
thank you
Questions, Dude?

I will use Google before asking dumb questions. I will use Google before asking dumb questions. I will use Google before asking dumb questions. I will use Google before asking dumb questions. I will use Google before asking dumb questions. I will use Google before asking dumb questions. I will use Google before asking dumb questions. I will use Google before asking dumb questions. I will use Google before asking dumb questions. I will use Google before asking dumb questions. I will use Google before asking dumb questions. I will use Google before asking dumb questions. I will use Google before asking dumb questions.
References


• SCAT-3- Download at http://bjsm.bmj.com/content/47/5/259.full.pdf


• Thomas D, Apps J et al Pediatrics 2015;135 (2); 213-223
References

• Meehan WP Clin Sports Med; 30(1): 115
• Gomez-Pinilla F Nature Rev Neuro 9, 568-578 2008
• Giza C, Hovda D Neurosurgery 75:S24–S33, 2014
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Arizona Institute for Sports Medicine
Phone: 520-626-6363
E-mail: dporter@email.arizona.edu
Integrating all data in decision-making in concussion management
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Concussion in Sport, An Update

Saturday, April 25, 2015
Donald E. Porter, MD
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