Disclosure

• Neither I, Cindy J. Chang, nor any family member(s), have any relevant financial relationships to be discussed, directly or indirectly, referred to or illustrated with or without recognition within the presentation.
Case A

• 16 year old female football goalie comes into your office for follow up of a wrist injury and also mentions that...
• A basketball hit her in the head during PE class yesterday. She initially felt dizzy and foggy, but cleared after 5 minutes, so she continued participating. She felt tired and took a nap after school.
• When she awoke, she had a headache, which worsened as she tried to study.
• In three days, she is playing against their high school rival. She denies having a headache today and school was “fine.”
• Her HS soccer coach wants a letter for her wrist saying she is cleared to play. Her coach doesn’t know about her headache.

• Should you clear her to play?
Case B

- 9 year boy was skating at the ice rink with friends when he slipped, and hit the occipital region of his head.
- His friends state that he was “out” for at least 5 seconds. When he came to, he “felt fine” but decided to stop skating because his neck was sore.
- His mom brings him to see you the next day because he had a hard time at school with the noise; he also felt foggy and says it was hard to pay attention. He also got a headache.

- **When should you advise that he returns to school?**
Objectives

1. Discuss the recommended return to learn (RTL) and return to play (RTP) guidelines
2. Review some of the evidence behind RTL and RTP guidelines for concussions in young athletes
3. Cite the current concussion legislation in California
Sometimes it can be challenging...

- Concussion is defined as a traumatically induced transient disturbance of brain function and involves a complex pathophysiological process.
- Concussion is a subset of mild traumatic brain injury (MTBI) which is generally self-limited and at the less severe end of the brain injury spectrum.
#1. You don’t have to get hit in the head to get a concussion

The biomechanical force can be a bump, blow, or jolt to the head

• The head does not have to be directly hit for the brain to be injured
  – Whiplash
#2. You don’t have to lose consciousness to have had a concussion

- Fewer than 10% of concussions involve a loss of consciousness (LOC)
#3. Just because you don’t have symptoms right away doesn’t mean you don’t have a concussion

- Evolving injury; serial assessments
- The “Monday Concussion”
- Don’t underestimate adrenaline or rationalization
#4. Wearing a helmet or other protection doesn’t prevent a concussion
#5. A normal head CT scan or MRI does not mean the brain is okay

A concussion causes a temporary disruption of normal neurological functioning

- Disruption in functioning = symptoms

- Force to brain
- Ion fluxes; vasoconstriction
- Need glucose but less blood flow
- Energy crisis
Concussion Symptoms

- Physical
- Cognitive
- Sleep
- Emotional
Brain Changes = Signs and Symptoms

**Physical**
- Headache
- Fuzzy or blurry vision
- Nausea or vomiting (early on)
- Dizziness
- Sensitivity to noise or light
- Balance problems
- Feeling tired, having no energy

**Sleep**
- Sleeping more than usual
- Trouble falling asleep
- Sleep less than usual
Brain Changes = Signs and Symptoms

Cognitive
- Difficulty thinking clearly/Foggy
- Dazed or feeling “out of it”
- Feeling slowed down
- Difficulty concentrating
- Difficulty remembering new information

Emotional
- Irritability
- Nervousness or anxiety
- Sadness
- More emotional
#6. Do not grade concussions

- Having certain symptoms, or more or less symptoms, does not make a concussion more mild or more severe

Each Concussion is Unique
# Concussion Grading

<table>
<thead>
<tr>
<th>Author</th>
<th>Grade I</th>
<th>Grade II</th>
<th>Grade III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cantu¹</td>
<td>No LOC PTA&lt;30’</td>
<td>LOC&lt;5’ or PTA&gt;30’ but &lt;24°</td>
<td>LOC&gt;5’ or PTA&gt;24°</td>
</tr>
<tr>
<td>Colorado Medical Society²</td>
<td>No LOC Confusion w/o amnesia</td>
<td>No LOC Confusion with amnesia</td>
<td>LOC</td>
</tr>
<tr>
<td>American Academy of Neurology³</td>
<td>No LOC Transient confusion Sx last &lt;15’</td>
<td>No LOC Transient confusion Sx last &gt;15’</td>
<td>Any LOC</td>
</tr>
</tbody>
</table>

2. CMS, 1991
3. AAN, Neurology 1997
### Return to Play Criteria After 1st Concussion

<table>
<thead>
<tr>
<th>Author</th>
<th>Grade I</th>
<th>Grade II</th>
<th>Grade III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cantu¹</td>
<td>RTP if asymptomatic</td>
<td>RTP in 1 wk if asymp or RTP within 2 wks if asymp for preceding 7 days</td>
<td>RTP in 1 mo if asymp for final 1 wk</td>
</tr>
<tr>
<td>Colorado Medical Society²</td>
<td>RTP if asymp at rest and exertion after 20’</td>
<td>RTP in 1 wk if asymp at rest and exertion</td>
<td>RTP in 1 mo if asymp at rest and exertion for 2 wks</td>
</tr>
<tr>
<td>American Academy of Neurology³</td>
<td>RTP if asymp within 15’</td>
<td>RTP after 1 wk w/o symptoms at rest and exertion</td>
<td>If brief LOC (sec), RTP after 2 wks w/o sx; if prolonged (min), RTP ≥1 mo</td>
</tr>
</tbody>
</table>

2.CMS, 1991  
3.AAN, Neurology 1997
So how do we know when it is okay or even safe to return to play?
Football Refining Postconcussion Testing

The NFL neuropsychological testing approach is now used routinely by teams at a handful of universities, including Michigan State and Georgia, Dr. Lovell said at the annual meeting of the American Medical Society for Sports Medicine.

By developing software to enable testing by laptop computer, Dr. Lovell hopes to reduce costs by eliminating the need for an on-site neuropsychologist. That could make neuropsychological testing more widely available at the college and high school levels.

This season 5-10 NFL teams will participate in the program, which entails prescreen baseline testing of every athlete, followed by repeat testing 24-48 hours after a suspected head injury. Testing continues on a weekly basis until the results return to baseline, said Dr. Lovell, director of neuropsychology at the Henry Ford Health System, Detroit.

He developed the neuropsychological test battery used in the league and by a growing number of National Hockey League teams. The battery was first used in a pilot project involving the Pittsburgh Steelers in 1993.

The tests are designed to detect often-subtle postconcussive deficits in concentration, motor dexterity, memory, and information processing. (See chart below.) The tests collectively assess an individual's ability to process new information rapidly, which is where one sees neurocognitive problems following a concussion, Dr. Lovell said.

Baseline testing, although costly and time consuming, is necessary because pro athletes vary widely in performance on neuropsychological tests. Some have learning disabilities or a history of multiple prior concussions, which would throw off their postinjury test results if they were to be compared to anyone but themselves, he said.

<table>
<thead>
<tr>
<th>Pittsburgh Steelers Neuropsychological Test Battery</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tests (in order administered)</strong></td>
</tr>
<tr>
<td>Orientation Questionnaire</td>
</tr>
<tr>
<td>Hopkins Verbal Learning Test</td>
</tr>
<tr>
<td>Trail Making Test</td>
</tr>
<tr>
<td>Stroop Test</td>
</tr>
<tr>
<td>Controlled Oral Words Association Test</td>
</tr>
<tr>
<td>Digit Span (from the Wechsler Memory Scale, revised)</td>
</tr>
<tr>
<td>Symbol Digit Modalities</td>
</tr>
<tr>
<td>Grooved Pegboard Test</td>
</tr>
<tr>
<td>Delayed recall from the Hopkins Verbal Learning Test</td>
</tr>
<tr>
<td>Ability Assessed</td>
</tr>
<tr>
<td>orientation, post-traumatic amnesia</td>
</tr>
<tr>
<td>verbal memory</td>
</tr>
<tr>
<td>visual scanning, mental flexibility</td>
</tr>
<tr>
<td>attention, mental flexibility</td>
</tr>
<tr>
<td>word fluency and retrieval</td>
</tr>
<tr>
<td>attention span</td>
</tr>
<tr>
<td>visual scanning and attention</td>
</tr>
<tr>
<td>motor speed and coordination</td>
</tr>
<tr>
<td>delayed memory of a previously learned word list</td>
</tr>
</tbody>
</table>

Source: Mark R. Lovell, Ph.D.
ICA Head Injury Assessment Form A (Yellow)

Test 1 (SEQUENTIAL ORDER IN 90 SECONDS)

Digit

Symbol

Results of Test 1

Test 2 Reverse Month

Time (sec.)

# errors

Test 3 Reverse Digit

Number

Test 4 Memory (5 Words)

Memory (5 Words)

/5

TEST 2 Reverse Months

(Have them recite the months in reverse order starting from December and ending with January. Time them in seconds and record the number of errors)

1) December November October September August July June May April March February January

TEST 3 Reverse Digit

Pick one number set per column

Start on the left side and continue only when they answer correctly

1

7-3-8

2

8-4-1-9

3

5-2-1-8-3

9-4-3

5-1-3-2

1-8-4-2-7

7-9-6

8-6-0-9

1-0-7-4-6

8-0-4

2-9-3-1

3-6-4-7-5

TEST 4 Memory Test 5

Pick one word per column

(Test immediately, and then at end of entire exam)

1

CURTAIN

THUNDER

TAXI

CONTEST

TRAIN

2

ORANGE

SALT

PROOF

DREAM

SWEET

3

ABSENT

COMMAND

NERVOUS

BALANCE

HONESTY

4

JUNGLE

NEWS

FEATHER

ONION

OPEN

5

SOAP

PRETEND

STAR

FOOT

JUNGLE
Brief Visual-Spatial Memory Test (Stimulus Card) Form 2

Brief Visual Spatial Memory Test
Trial 2
X’ S AND O’ S (Working Memory)

Remember the location of the highlighted symbols
VISUAL MEMORY DISTRACTOR
Reaction Time Task

Click the left mouse button when you see this

Click the right mouse button when you see this
VISUAL MEMORY DISTRACTOR
Reaction Time Task

Click the left mouse button when you see this

Click the right mouse button when you see this
VISUAL MEMORY DISTRACTOR
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VISUAL MEMORY DISTRACTOR

Reaction Time Task

Click the left mouse button when you see this

Click the right mouse button when you see this
X’S AND O’S (Working Memory)

Remember the location of the highlighted symbols
Outcome measure is Speed reported as Working Memory

Outcome measure is Speed reported as Attention
Neuropsychological Testing

• With baseline data and post-injury testing, data is **objective**
• Valuable adjunct to the management of concussions; may protect those patients who minimalize their symptoms in order to be cleared
• But still just a “tool in the toolbox”
“Window of Vulnerability”

- The period between the concussion and recovery
- Return-to-play during this time could cause more severe or even catastrophic brain injury

Giza and Hovda, JAT 2001

- May be unsafe to return to competition until brain activity has returned to normal
- *In rats*, that time period averages ~10 days

Figure 5. Neurometabolic Cascade Following Traumatic Brain Injury

Giza and Hovda, JAT 2001
First International Conference on Concussion in Sport, Vienna 2001

- Acknowledged that scientifically validated RTP guidelines are absent; *abandon grading scales*

- Return to play must follow medically supervised stepwise process
  - athlete must first be *completely asymptomatic and have normal neurological and cognitive evaluations*
  - neuropsychological testing one of the *cornerstones* of concussion evaluation; *baseline testing recommended*

- **No mention of pediatric/adolescent athlete**

Aubrey et al, BJSM 2002
• Even athletes who said they had ‘recovered’ within minutes of a concussion still showed abnormalities on cognitive tests 36 hours later

• Evidence that no youth athlete “recovers” on the same day of injury
• Individually guide RTP decisions based on combined measures of recovery; determine concussion severity in *retrospect*

• Recommendations *applicable to children* *(5-18 yoa)*

• Concept of “cognitive rest” -- limit exertion with ADL; *limit scholastic activities* while symptomatic

• May be appropriate to *extend asymptomatic rest and/or length of the graded exertion* in children and adolescents.

McCrorry et al, BJSM 2005
• Recommended that neuropsychological testing remain one of the cornerstones of evaluation for complex concussion
  – should not be the sole basis of management decisions
• Recommended that, in organized high risk sports, consideration be given to having cognitive evaluation regardless of the age or level of performance.

McCrory et al, BJSM 2005
Introduced the standardized Sport Concussion Assessment Tool, or SCAT card

- For patient education as well as physician sideline assessment

McCrorery et al, BJSM 2005
Athlete Concussion Recovery Time

Collins et. al., Neurosurgery 2006
Postural Stability and BESS
(Balance Error Scoring System)

• What is the effect of concussion on motor control?
• Balance is maintained by integration of visual, vestibular, and somatosensory information
• Impairment usually lasts up to 3 days

Majority (80-90%) of concussions resolve in a short period (7-10 day) but recovery time frame may be longer in children and adolescents.

Recommendations applied down to the age of 10 yo.

- Younger children report different concussion symptoms.
- May need to include adult input.
• Occasionally in adult athletes, with experienced team physicians and sufficient resources, same day RTP
  – Yet the young elite athlete, with the same resources, should be treated more conservatively
    • Not appropriate to RTP same day

• No RTP until clinically symptom-free
  – Ongoing cognitive maturation in children limits the utility of comparing to a baseline NP test

McCrory et al, JAT 2009
Balance examination

This balance testing is based on a modified version of the Balance Error Scoring System (BESS). A stopwatch or watch with a second hand is required for this testing.

Balance testing

“*I am now going to test your balance. Please take your shoes off, roll up your pant legs above ankle (if applicable), and remove any ankle taping (if applicable). This test will consist of three twenty second tests with different stances.*”

(a) Double leg stance:

“The first stance is standing with your feet together with your hands on your hips and with your eyes closed. You should try to maintain stability in that position for 20 seconds. I will be counting the number of times you move out of this position. I will start timing when you are set and have closed your eyes.”

(b) Single leg stance:

“If you were to kick a ball, which foot would you use? [This will be the dominant foot] Now stand on your non-dominant foot. The dominant leg should be held in approximately 30 degrees of hip flexion and 45 degrees of knee flexion. Again, you should try to maintain stability for 20 seconds with your hands on your hips and your eyes closed. I will be counting the number of times you move out of this position. If you stumble out of this position, open your eyes and return to the start position and continue balancing. I will start timing when you are set and have closed your eyes.”

(c) Tandem stance:

“Now stand heel-to-toe with your non-dominant foot in back. Your weight should be evenly distributed across both feet. Again, you should try to maintain stability for 20 seconds with your hands on your hips and your eyes closed. I will be counting the number of times you move out of this position. If you stumble out of this position, open your eyes and return to the start position and continue balancing. I will start timing when you are set and have closed your eyes.”

Cognitive assessment

Standardized Assessment of Concussion (SAC)

Orientation (1 point for each correct answer)

<table>
<thead>
<tr>
<th>What month is it?</th>
<th>What is the date today?</th>
<th>What is the day of the week?</th>
<th>What year is it?</th>
<th>What time is it right now? (within 1 hour)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Orientation score: 0 of 5

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 remember, in any order.”

Trials 2 & 3:

“I am going to repeat the same list again. Repeat back as many words as you can remember in any order, even if you said the word before.”

Complete all 3 trials regardless of score on trial 1 & 2. Read the words at a rate of one per second. Score 1 pt. for each correct response. Total score equals sum across all 3 trials. Do not inform the athlete that delayed recall will be tested.

Concentration

Digits Backward:

“I am going to read you a string of numbers and when I am done, you repeat them back to me backwards, in reverse order of how I read them to you. For example, if I say 7-1-9, you would say 9-1-7.”

If correct, go to next string length. If incorrect, read trial 2. One point possible for each string length. Stop after incorrect on both trials. The digits should be read at the rate of one per second.

<table>
<thead>
<tr>
<th>Alternative digit lists</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-9-3</td>
</tr>
<tr>
<td>3-8-1-4</td>
</tr>
<tr>
<td>6-2-9-7-1</td>
</tr>
<tr>
<td>7-1-8-4-6-2</td>
</tr>
</tbody>
</table>

Months in Reverse Order:

“Now tell me the months of the year in reverse order. Start with the last month and go backward. So you’ll say December, November ... Go ahead”

1 pt. for entire sequence correct

Dec-Nov-Oct-Sept-Aug-Jul-Jun-May-Apr-Mar-Feb-Jan: 0 1
Modified BESS Test

1. the hands coming off of the iliac crest
2. opening the eyes
3. stepping, stumbling, or falling
4. moving the hip into greater than 30 degrees of abduction
5. lifting the forefoot or heel
6. remaining out of the test position longer than 5 seconds
Exercise Training for Refractory Post-Concussion Symptoms

• Rehabilitation program implemented for children with PCS > 4 wks
  – Submaximal (50-60%) aerobic training up to 15 min
  – Light coordination exercises up to 10 min
    • Increase self-efficacy
  – Stop if any increase in symptoms

• Home program

• Weekly follow-up

Gagnon et al, Brain Injury 2009
Exercise Training for Refractory Post-Concussion Symptoms

• Buffalo Concussion Treadmill Test
• Aerobic exercise improves symptoms and outcome in adults with post concussive syndrome (PCS)

Leddy et al, CJS 2010, 2011
Fourth International Conference on Concussion in Sport, Zurich 2012

• RTP guidelines
  – Evidence of long-term outcome of rest and the optimal amount and type of rest remains “sparse”
  – *Low level of exercise for those slow to recover may be beneficial*

McCrory et al, JAT 2013
• No return to sport or activity should occur before the youth athlete has returned to school successfully
• Limit exertion with ADL that may exacerbate symptoms (cognitive rest); modify school attendance and activities
• NP testing typically done when clinically asymptomatic to help with RTP decisions
  – May be impt in early stages for help with mgmt of return to school
  – Still insufficient evidence to recommend mandatory baseline testing

• **Child SCAT3 introduced for children 5-12 yo**
**WHAT IS THE SCAT3?**

The SCAT3 is a standardized tool for evaluating injured athletes for concussion and can be used by athletes aged 13 years and older. It supplements the original SCAT and the SCAT2, published in 2005 and 2009, respectively. For younger participants, up to age 12, please use the Child SCAT2. The SCAT3 is designed for use by medical professionals. If you are not qualified, please use the Sport Concussion Recognition Tool. Preseason baseline testing with the SCAT3 can be helpful for managing post-injury test scores.

Specific instructions for use of the SCAT3 are provided on page 3. If you are not familiar with the SCAT3, please read through these instructions carefully. This tool may be freely copied in its current form for distribution to individuals, teams, and organizations. Any revision or reproduction in a digital form requires approval by the Concussion in Sport Group.

**INDICATIONS FOR EMERGENCY MANAGEMENT**

**Background**

- Name:
- Date:
- Examiner:
- Date/Time of injury:
- Age:
- Years of education completed:
- Dominant hand:
- How many concussions do you think you have had in the past?
- When was the most recent concussion?
- How long was your recovery from the most recent concussion?
- Have you ever been hospitalized or had medical imaging done for a head injury?
- Have you ever been diagnosed with headaches or migraines?
- Do you have any other head injuries, dizziness, or dizziness?
- Have you ever been diagnosed with depression, anxiety, or other psychiatric disorder?
- Has your family ever been diagnosed with any of these problems?
- Are you on any medications? If yes, please list.

**SYMPTOM EVALUATION**

How do you feel?

- **Headache**: none, mild, moderate, severe
- **Nausea or vomiting**: no, yes
- **Dizziness**: no, yes
- **Blurred or double vision**: no, yes
- **Balance problems**: no, yes
- **Sensitivity to light**: no, yes
- **Sensitivity to noise**: no, yes
- **Feeling slowed down**: no, yes
- **Feeling like “in a fog”**: no, yes
- **Don’t feel right**: no, yes
- **Difficulty concentrating**: no, yes
- **Difficulty with memory**: no, yes
- **Fatigue or low energy**: no, yes
- **Confusion**: no, yes
- **Drowsiness**: no, yes
- **Trouble sleeping**: no, yes
- **Mood swings**
- **More emotional**
- **Irritability**
- **Sadness**

**Maddocks Score**

A score of 2 or more on any of the following signs indicates a possible concussion:

- **Loss of consciousness**
- **If so, how long?**
- **Balance or motor incoordination**
- **Seizure or loss of consciousness, etc.**
- **Deorientation or confusion**
- **Partial or total loss of memory**
- **Loss of memory**
- **Before or after the injury?**
- **Visible facial injury**

Any athlete with a suspected concussion should be 

**RER FROM PLAY**

In medical assessment, monitored for distress (i.e., should not be left alone) and should not drive a motor-vehicle cleared to do so by a professional medical health professional. No athlete needs to be monitored for symptoms and should be returned to sports participation on the day of injury.

**COGNITIVE & PHYSICAL EVALUATION**

**Cognitive assessment of Concussion (SAC)**

- **Orientation**
- **If correct answer**
- **What month is it?**
- **What is the date today?**
- **What is the day of the week?**
- **What year is it?**
- **When is it rush period?**

**Immediate memory**

- **Commonplace objects**
- **Digit span**
- **Adequate answer or no**

**Concentration**

- **Digits backward**
- **Digit span**

**SAC Delayed Recall**

**Coordination examination**

- **Upper limb coordination**
- **Rapid finger tapping**

**Modified Balance Error Scoring System (BBESS)**

**Testing surface**

- **Testing surface**
- **Testing surface**
- **Testing surface**
- **Testing surface**
- **Testing surface**
- **Testing surface**

**Notes:**

- Mechanism of injury (Tell me what happened)
- Any loss of consciousness?
- Any loss of consciousness?
- Any loss of consciousness?
- Any loss of consciousness?
- Any loss of consciousness?
- Any loss of consciousness?
- Any loss of consciousness?
- Any loss of consciousness?
- Any loss of consciousness?
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- Any loss of consciousness?
**SYMPTOM EVALUATION**

**Child report**

Name: 

I have trouble paying attention: 0 2 3
I get distracted easily: 0 2 3
I have a hard time concentrating: 0 2 3
I have problems remembering what people tell me: 0 2 3
I have problems following directions: 0 2 3
I daydream too much: 0 2 3
I get confused: 0 2 3
I forget things: 0 2 3
I have trouble figuring things out: 0 2 3
It's hard for me to learn new things: 0 2 3
I feel dizzy: 0 2 3
I feel like the room is spinning: 0 2 3
I can't focus: 0 2 3
Things are blurry when I look at them: 0 2 3
I see double: 0 2 3
I feel sick to my stomach: 0 2 3
I get a lot of headaches: 0 2 3
I get tired easily: 0 2 3

Total number of symptoms (Maximum possible: 20)

**Parent report**

The child is easily distracted: 0 2 3
Has difficulty concentrating: 0 2 3
Has problems remembering what he/she is told: 0 2 3
Has problems following directions: 0 2 3
Tends to daydream: 0 2 3
Gets confused: 0 2 3
Forgets things: 0 2 3
Has difficulty completing tasks: 0 2 3
Has poor problem solving skills: 0 2 3
Has problems learning: 0 2 3
Has headaches: 0 2 3
Feels dizzy: 0 2 3
Feeling that the room is spinning: 0 2 3
Feeling faint: 0 2 3
Has blurred vision: 0 2 3
Has double vision: 0 2 3
Experiences nausea: 0 2 3
Gets a lot of headaches: 0 2 3
Tired easily: 0 2 3

Total number of symptoms (Maximum possible: 20)

**BACKGROUND**

**Glasgow coma scale (GCS)**

Best eye response (E)  
No eye opening: 1
Eye opening in response to pain: 2
Eye opening spontaneously: 4

Best verbal response (V)  
No verbal response: 1
Incomprehensible sounds: 2
Clock: 5

Best motor response (M)  
No motor response: 1
Abnormal: 5

Glasgow Coma Scale (E + V + M)  

CSC is recorded for all athletes in case of subsequent deterioration.

---

**Cognitive & Physical Evaluation**

**Cognitive Assessment**

Standardized Assessment of Concussion - Child Version (SAC-C)

**Orientation**

- What month is it?
- What is the date today?
- What is the day of the week?
- What year is it?
- Orientation score: 1

**Immediate memory**

- Date/Time: 1
- Alternative digit span: 1

**Concentration**

- Days in reverse order: 5
- Total: 5

**Neck Examination**

Range of motion: Tenderness: Upper and lower limb sensation:

**Balance Examination**

Modified Balance Error Scoring System (MBESS) testing: 
- Right Left
- Testing surface: Hard floor, soft floor, etc.

**Coordination Examination**

Upper limb coordination: 
- Right Left
- Coordination score: 1

---

Scoring on the Child-SCAT3 should not be used as a stand-alone method to diagnose concussion, measure recovery or make decisions about an athlete's readiness to return to competition after concussion.
### Child report

<table>
<thead>
<tr>
<th>Symptom</th>
<th>never</th>
<th>rarely</th>
<th>sometimes</th>
<th>often</th>
</tr>
</thead>
<tbody>
<tr>
<td>I have trouble paying attention</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>I get distracted easily</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>I have a hard time concentrating</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>I have problems remembering what people tell me</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>I have problems following directions</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>I daydream too much</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>I get confused</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>I forget things</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>I have problems finishing things</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>I have trouble figuring things out</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>It’s hard for me to learn new things</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>I have headaches</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>I feel dizzy</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>I feel like the room is spinning</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>I feel like I’m going to faint</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Things are blurry when I look at them</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>I see double</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>I feel sick to my stomach</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>I get tired a lot</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>I get tired easily</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

### Total number of symptoms (Maximum possible 20)

### Symptom severity score (Maximum possible 20 x 3 = 60)

### Parent report

<table>
<thead>
<tr>
<th>Symptom</th>
<th>never</th>
<th>rarely</th>
<th>sometimes</th>
<th>often</th>
</tr>
</thead>
<tbody>
<tr>
<td>The child</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>has trouble sustaining attention</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>is easily distracted</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>has difficulty concentrating</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>has problems remembering what he/she is told</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>has difficulty following directions</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>tends to daydream</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>gets confused</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>is forgetful</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>has difficulty completing tasks</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

### 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>0</td>
<td>1</td>
</tr>
<tr>
<td>Which half is it now?</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Who scored last in this match?</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>What team did you play last week/game?</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Did your team win the last game?</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

**Maddocks score**

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

### Sideline Assessment – child-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>Where are we at now?</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Is it before or after lunch?</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>What did you have last lesson/class?</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>What is your teacher’s name?</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

**child-Maddocks score**

Child-Maddocks score is for sideline diagnosis of concussion only and is not used for serial testing.
### Cognitive Assessment
**Standardized Assessment of Concussion – Child Version (SAC-C)**

<table>
<thead>
<tr>
<th>Orientation (1 point for each correct answer)</th>
<th>0</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>What month is it?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>What is the date today?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>What is the day of the week?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>What year is it?</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Orientation score</strong></td>
<td></td>
<td>4</td>
</tr>
</tbody>
</table>

#### 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>1</td>
<td>candle, baby, finger</td>
</tr>
<tr>
<td>apple</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>paper, monkey, penny</td>
</tr>
<tr>
<td>carpet</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>sugar, perfume, blanket</td>
</tr>
<tr>
<td>saddle</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>sandwich, sunset, lemon</td>
</tr>
<tr>
<td>bubble</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>wagon, iron, insect</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Immediate memory score total</strong></td>
<td></td>
<td>15</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Concentration: Digits Backward

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

#### Concentration: Days in Reverse Order (1 pt. for entire sequence correct)

<p>| |</p>
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sunday-Saturday-Friday-Thursday-Wednesday-Tuesday-Monday</td>
</tr>
</tbody>
</table>

### Balance Examination

Do one or both of the following tests.

- **Footwear (shoes, barefoot, braces, tape, etc.)**
- **Testing surface (hard floor, field, etc.)**

#### Modified Balance Error Scoring System (BESS) testing

<table>
<thead>
<tr>
<th>Condition</th>
<th>Left</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>Double leg stance:</td>
<td>Errors</td>
<td>Errors</td>
</tr>
<tr>
<td>Tandem stance (non-dominant foot at back):</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Tandem Gait

Time taken to complete (best of 4 trials): [seconds]

If child attempted, but unable to complete tandem gait, mark here
What will be discussed at the **Fifth** International Conference on Concussion in Sport in 2016?
Can the Child SCAT3 be validated?

- **Cognition**
  - Over 1/3 of all children didn’t know the date
  - **70% 5-7 yo**, 39% 8-10 yo, 23% 11-13 yo

- **Concentration—days of week**
  - 88% correct
  - Of 56 who couldn’t, **63% were 5-7 yo**

---

**Cognitive & Physical Evaluation**

**Cognitive assessment**
Standardized Assessment of Concussion – Child Version (SAC-C)

<table>
<thead>
<tr>
<th>Orientation (1 point for each correct answer)</th>
</tr>
</thead>
<tbody>
<tr>
<td>What month is it?</td>
</tr>
<tr>
<td>What is the date today?</td>
</tr>
<tr>
<td>What is the day of the week?</td>
</tr>
<tr>
<td>What year is it?</td>
</tr>
<tr>
<td><strong>Orientation score</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Concentration: Days in Reverse Order (1 pt. for entire sequence correct)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sunday-Saturday-Friday-Thursday-Wednesday-Tuesday-Monday</td>
</tr>
</tbody>
</table>

Brooks et al. AMSSM Research Podium Presentation April 2015; publication pending
Can the Child SCAT3 be validated?

• BESS
  • Statistically significant differences between males/females (males worse) and ages 5-9/10-13 (younger worse)

• Tandem Gait
  • Statistically significant differences between ages 5-9/10-13 (younger worse)

Brooks et al. AMSSM Research Podium Presentation April 2015; publication pending
Will sub-concussive injuries be addressed?

- Prospective study of early adolescent rugby players vs. non-contact sports controls
- Differences in the neurocognitive functioning (over 3 years) and academic performances (over 6 years)
- Correlational findings rather than causative

Alexander et al Brain Injury 2015
Remember:

Return to Learn

BEFORE

Return to Play
Return to Learn

• Again, based on expert opinion
  – Cognitive rest
    • Benefit vs. harm re: prolongation of symptoms or ultimate outcome
    • Will restrictions create more emotional stress?

• The Hidden Injury
  – Teacher doubt, anger at extra work
  – Coach doubt, anger at lack of toughness
  – Balance being at school vs. home
  – Socialization component of recovery
  – Increasing anxiety at falling behind in school
  – Loss of identity as an athlete

Halstead et al, Pediatrics 2013
What can improve recovery in our young athletes with concussion?
What can improve recovery in our young athletes with concussion?

• If the child is evaluated within one week of injury by a concussion specialist
  – 16d vs. 36d (p < 0.001)

  ➢ Let’s educate and build a larger network of trained knowledgeable providers

• If the child reported a headache on the field at time of injury
  – 23d vs. 33d (p < 0.001)

  ➢ Let’s educate more of our children—and their teammates and coaches-- about the various signs and symptoms of concussions

Bock et al Childs Nerv Syst 2015
Education of Healthcare Providers:
How many counsel strict rest after acute concussion?

• 88 patients (11-22 yoa) seen at pediatric ED randomized
  – Strict rest x 5 days vs. “usual care” of 1-2 days rest, then stepwise return to activity

• Neurocognitive and balance outcomes same

• Strict rest group had more daily post concussive symptoms and slower symptoms resolution

Thomas et al, Pediatrics 2015
Education of Healthcare Providers
Who is at risk for prolonged recovery?

- LOC > 1 minute
- Amnesia
- Convulsions
- History of multiple concussions
- Injuries close together in time
- Repeat injuries with less and less force
- Younger age
- Female sex
- Migraine headaches
- Depression/other mood disorders
- ADHD/other learning and attention disorders
- Sleep disorders

Broglio et al. J of Athletic Training 2014
**Education of the Public:**
California State Laws

- **AB 25 – Concussion Law 2012**
  - 3 parts (education, remove from play, written medical note to return)

- **AB 1451—Coaches Concussion Training Law 2013**
  - Mandatory education every 2 years

- **AB 2127 – Concussion Safety Law 2015**
  - Limit American FB full-contact practices
  - Mandatory RTP protocol of **no less than 7 days from the diagnosed date of concussion**
  - RTP under the supervision of LHCP
Concussion Information Sheet
Acute Concussion Notification Form
Graded Concussion Symptom Checklist
Physician Letter to School After Concussion Visit
Concussion Return to Learn (RTL) Protocol
Physician Recommended School Accommodations Following Concussion
Concussion Return to Play (RTP) Protocol

http://cifstate.org/sports-medicine/concussions/index
Legislation or Education?

Let’s do both.
So now...what would you do?
Case A

• 16 year old female football goalie comes into your office for follow up of a wrist injury and also mentions that...
• A basketball hit her in the head during PE class yesterday. She initially felt dizzy and foggy, but cleared after 5 minutes, so she continued participating. She felt tired and took a nap after school.
• When she awoke, she had a headache, which worsened as she tried to study.
• In three days, she is playing against their high school rival. She denies having a headache today and school was “fine.”
• Her HS soccer coach wants a letter for her wrist saying she is cleared to play. Her coach doesn’t know about her headache.

• Should you clear her to play?

http://cifstate.org/sports-medicine/concussions/index
Case B

• 9 year boy was skating at the ice rink with friends when he slipped, and hit the occipital region of his head.

• His friends state that he was “out” for at least 5 seconds. When he came to, he “felt fine” but decided to stop skating because his neck was sore.

• His mom brings him to see you the next day because he had a hard time at school with the noise; he also felt foggy and says it was hard to pay attention. He also got a headache.

• When should you advise that he returns to school?

http://cifstate.org/sports-medicine/concussions/index
Thank You
for your attention!
Parents File Concussion Lawsuit Against FIFA, U.S. Soccer and Youth Soccer
Avoid heading?

Reasons for concussion in soccer

1. Contact with another player (50-70%)
2. Heading (30%)
   1. Athlete-athlete contact
   2. Contact with playing apparatus, including ball
   3. Contact with playing surface

Comstock at al JAMA Pediatr. 2015
• No RTP same day
• If concussion proved
  – an adult player can RTP after 19 days at the earliest
  – For an under-19 player--23 days
• If “enhanced” level of medical care, shorter timeframe possible
Concussion Epidemiology – Athletic Trainer Data

- Athletic trainer data shows that around 5% of football players suffer concussions each year.

<table>
<thead>
<tr>
<th>Source</th>
<th>Level</th>
<th>Incidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Powell et al (1999)</td>
<td>High School</td>
<td>3.6 %</td>
</tr>
<tr>
<td>Guskiewicz et al (2000)</td>
<td>HS/College</td>
<td>5.6 %</td>
</tr>
<tr>
<td>Guskiewicz et al (2003)</td>
<td>NCAA</td>
<td>6.3 %</td>
</tr>
<tr>
<td>McCrea et al (2002)</td>
<td>HS/College</td>
<td>3.8 %</td>
</tr>
<tr>
<td>Zemper (2003)</td>
<td>HS/College</td>
<td>4.1 %</td>
</tr>
<tr>
<td>Gerberich et al (1983)</td>
<td>High School</td>
<td>2.4 %</td>
</tr>
</tbody>
</table>
Concussion Epidemiology – Athletic Trainer Data

- Surveys of athletes show that around 50% of football players suffer concussions each year.

<table>
<thead>
<tr>
<th>Source</th>
<th>Level</th>
<th>Incidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Langburt et al (2001)</td>
<td>High School</td>
<td>47.2 %</td>
</tr>
<tr>
<td>Delaney et al (2002)</td>
<td>College</td>
<td>70.2 %</td>
</tr>
<tr>
<td>Delaney et al (2000)</td>
<td>CFL</td>
<td>47.8 %</td>
</tr>
<tr>
<td>Woronzoff (2001)</td>
<td>College</td>
<td>61.2 %</td>
</tr>
<tr>
<td>Moreau (2005)</td>
<td>High School</td>
<td>65.2 %</td>
</tr>
</tbody>
</table>