Head Injuries in the Young Athlete: Who Plays? Who Sits?

Walter L. Calmbach MD MPH
Dept. of Family & Community Medicine
Univ. of Texas Health Science Center at San Antonio
Dr. Calmbach has disclosed that he has no actual or potential conflict of interest in relation to this topic.
Objectives

- Be aware of criteria for diagnosing sports-related concussion
- Be familiar with common tools for assessing and evaluating athletes with concussion
- Be aware of guidelines for managing the young athlete with concussion
- Be aware of return-to-play recommendations and controversies
After a sports-related concussion, the athlete can return to play:

1. When he/she feels better
2. After one week
3. When asymptomatic at rest
4. When asymptomatic at rest and with exertion x 1 week
5. None of the above
Audience Response Question 2

Which of the following is a good evaluation instrument for sports-related concussion?

1. SAC (Standardized Assessment of Concussion)
2. SCAT2 (Sport Concussion Assessment Tool 2, 2010)
3. BESS (Balance Error Scoring System)
4. ImPACT (Immediate Post-concussion Assessment and Cognitive Testing)
5. All of the above
Audience Response Question 3

Appropriate indications for neuroimaging in the athlete with suspected concussion include:

1. Severe headache
2. Focal neurological findings
3. Repeated vomiting
4. Significant drowsiness/difficulty awakening, Slurred speech
5. All of the above
Cases of second impact syndrome have been reported for which of the following sports?

1. Hockey
2. Skiing
3. Boxing
4. Contact/collision sports
5. All of the above
Concussions are Big News

- Pop Warner
  - New rules to limit practices and return to play
  - “When in doubt, sit them out!”

- UIL
  - House Bill 2038, changes to TEC section 38
  - [http://www.uiltexas.org/health/info/concussions](http://www.uiltexas.org/health/info/concussions)

- NFL
  - Multimillion-dollar-settlement to Rx players for concussions
  - New rules on helmet-to-helmet tackles, etc.
Concussions are Big News

- **NCAA**
  - Lawsuit: NCAA failed to take meaningful steps to prevent student athletes from sustaining concussions
  - CDC Website: “Attention College Sports Fans: CDC and NCAA Team Up on Concussion Safety”
    - Fact sheets for coaches and athletes
    - [http://www.cdc.gov/concussion/sports/cdc_ncaa.html](http://www.cdc.gov/concussion/sports/cdc_ncaa.html)
    - Sample concussion mgmt plans for team medical staff
  - “When in doubt get checked out.”
Concussion and Women’s Sports

- High School Sports: Girls have a higher rate of sports-related concussions than boys
- Women’s Sports: Highest incidence of concussions #1 soccer, #2 basketball
- NCAA: “It’s better to miss one game than the whole season”

www.womenssportsfoundation.org
Concussion is “a complex pathophysiological process affecting the brain caused by traumatic biomechanical forces.”

Common Features

- Rapid onset of usually short-lived neurological impairment, typically resolve spontaneously
- Acute clinical symptoms usually reflect a functional disturbance rather than structural injury
- Range of clinical symptoms (may or may not involve loss of consciousness)
- Neuroimaging studies are typically normal

Epidemiology

- Head injury twice as common as neck injury
- 20% of athletes affected each year
- Underreported:
  - Player not aware of significance of symptoms
  - Wants to avoid disqualification

Epidemiology of Concussion

- 30 million children and adolescents participate in organized sports in the US each year
- Concussion occurs in 1.6M-3.6 M young athletes each year
- High school:
  - 53% report history of at least one concussion
- College:
  - 36% report history of multiple concussions

Pathophysiology of Concussion

- Children seem to be more vulnerable to the effects of brain injury than adults
- Specific changes at the cellular level
  - “Metabolic mismatch”
    - Increased glucose utilization
    - Reduced cerebral blood flow
- Increased vulnerability to injury during the recovery period, 7-14 days

Pathophysiologic Cascade After Concussion Injury

- Concussion due to rotational and angular forces to brain
- Shear forces disrupt neural membranes
  - $\Rightarrow$ K+ efflux to extracellular space
- Increases in Ca++ and excitatory amino acids
  - $\Rightarrow$ further K+ efflux
  - $\Rightarrow$ suppresses neuron activity
- Na+/K+ pumps work to restore balance
  - $\Rightarrow$ increased energy requirement
- But, paradoxical decrease in cerebral blood flow
- Disruption of autonomic regulation persist for several weeks
  - $\Rightarrow$ brain vulnerable to additional injury

Guidelines (Historical Review)

- Overreliance on published guidelines
  - Nonuniformity
  - Lack of prospective validation
  - Use LOC as marker of severity
  - Individual variation in presentation and recovery after concussion

- Useful as starting point when evaluating athletes

- Rec: individualized management based on signs & symptoms and standardized assessment tools
On-Field Assessment

- Rule out serious injury
- Indications for emergency transport
- Sidelines assessment
Initial Assessment

- Athlete unconscious
  - Assume cervical spine injury
- Immobilize appropriately
  - Do not remove helmet or shoulder pads
  - Sandbags, Philadelphia collar
Initial Assessment

- **Athlete unconscious**
  - Check **DR ABC’s**:  
    - Remove from Danger  
    - Check **Responsiveness**  
      (AVPU)  
      - Alert  
      - Responds to Verbal stimuli  
      - Responds to Painful stimuli  
      - Unresponsive
Initial Assessment

- Athlete unconscious
  - Airway
  - Breathing
  - Circulation
  - Disability
  - Exposure
Initial Assessment

- Athlete conscious
  - Evaluate alertness, orientation
  - Post-traumatic amnesia
  - Ability to retain new information:
  - Standardized Assessment of Concussion form
Injury Assessment

- Neurological symptoms
  - Headache
  - Light-headedness
  - Balance
  - Coordination
  - Sensation
  - Motor function
  - Reflexes
Injury Assessment

- Stress importance of mental status
  - Concentration
  - Short-term memory
  - Orientation
Selected Signs and Symptoms

**Cognitive**
- Confusion
- Post-traumatic amnesia
- Retrograde amnesia
- Loss of consciousness
- Disorientation
- Feeling “zoned out”
- Vacant stare
- Inability to focus
- Excessive drowsiness

**Somatic**
- Headache
- Fatigue
- Disequilibrium
- Dizziness
- Nausea/vomiting
- Visual disturbances
- Photophobia
- Phonophobia
- Emotional lability, irritability

Transport to Emergency Facility

- Repeated vomiting
- Severe or progressively worsening headache
- Seizure activity
- Unsteady gait
- Slurred speech
- Weakness or numbness in the extremities
- Signs of basilar skull fracture
- Altered mental status
- Glasgow coma scale <15

Halstead ME, Pediatrics 2010; 126(3): 597-615.
Indication for Neuroimaging  
(CT is the Test of Choice)

- Severe headache
- Seizures
- Focal neurological findings
- Repeated emesis
- Significant drowsiness/difficulty awakening
- Slurred speech
- Poor orientation to person/place/time
- Neck pain
- Significant irritability
- Hx LOC > 30 seconds

Halstead ME, Pediatrics 2010; 126(3): 597-615.
Common Assessment Tools

- Standardized Assessment of Concussion (SAC)
- Sports Concussion Assessment Tool v2 (SCAT2)
- Balance Error Scoring System (BESS)
- Immediate Post-concussion Assessment and Cognitive Testing (ImPACT)
Standardized Assessment of Concussion (SAC), pt 1

- Orientation
- Immediate Recall
- Neurologic Screening
Standardized Assessment of Concussion (SAC), pt 2

- Concentration
  - Digits
  - Months
- Delayed Recall
- Score Total
Sports Concussion Assessment Tool v2 (SCAT2)
SCAT2 Pocket Card, pt 1

- Symptoms
  - Loss of Consciousness
  - Seizure or Convulsion
  - Headache, etc.

Pocket SCAT2

Concussion should be suspected in the presence of **any one or more** of the following: symptoms (such as headache), or physical signs (such as unsteadiness), or impaired brain function (e.g. confusion) or abnormal behaviour.

1. Symptoms

Presence of any of the following signs & symptoms may suggest a concussion.

- Loss of consciousness
- Seizure or convulsion
- Amnesia
- Headache
- “Pressure in head”
- Neck Pain
- Nausea or vomiting
- Dizziness
- Blurred vision
- Balance problems
- Sensitivity to light
- Sensitivity to noise
- Feeling slowed down
- Feeling like “in a fog”
- “Don’t feel right”
- Difficulty concentrating
- Difficulty remembering
- Fatigue or low energy
- Confusion
- Drowsiness
- More emotional
- Irritability
- Sadness
- Nervous or anxious
SCAT2 Pocket Card, pt 2

- Memory Function
  - Venue, half, score, etc.
- Balance Testing
- Remove from Play warning

2. Memory function
Failure to answer all questions correctly may suggest a concussion.

“At what venue are we at today?”
“Which half is it now?”
“Who scored last in this game?”
“What team did you play last weekend?”
“Did your team win the last game?”

3. Balance testing
Instructions for tandem stance
“Now stand heel-to-toe with your non-dominant foot in back. Your weight should be evenly distributed across both feet. 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.”

Observe the athlete for 20 seconds. If they make more than 5 errors (such as lift their hands off their hips; open their eyes; lift their forefoot or heel; step, stumble, or fall; or remain out of the start position for more than 5 seconds) then this may suggest a concussion.

Any athlete with a suspected concussion should be IMMEDIATELY REMOVED FROM PLAY, urgently assessed medically, should not be left alone and should not drive a motor vehicle.
# Balance Error Scoring System

## B.E.S.S. SCORERCARD

<table>
<thead>
<tr>
<th>Count Number of Errors</th>
<th>FIRM Surface</th>
<th>FOAM Surface</th>
</tr>
</thead>
<tbody>
<tr>
<td>Double Leg Stance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(feet together)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single Leg Stance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(non-dominant foot)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tandem Stance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(non-dominant foot in back)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TOTAL SCORES:**
- total each column
Neurocognitive Testing (ImPACT)

- ImPACT (Immediate Post-concussion Assessment and Cognitive Testing): computerized neurocognitive assessment
- Objectively evaluate post-injury status, track recovery for safe return to play, esp. if baseline testing is present
- Can be administered by: athletic trainer, school nurse, athletic director, coach, team physician, or trained layperson
ImPACT Test Features

- Measures athlete symptoms, verbal/visual memory, processing speed, reaction time
- Reliable baseline test information
- Stores data from repeat testing
- Administered online for individuals or groups
- Test items varies to minimize practice effects
- Cost: 300 athletes $500, 600 athletes $750, 1000 athletes $1000
“Minor” Head Injury

- No such thing as a “minor head injury”
- Decreased ability to process new information
- Degree of impairment proportional to severity of injury
- Symptoms worsen with repeated injury
  - “Cumulative concussion”
- “No head injury is minor; all need prompt evaluation before return to play”
Considerations in Concussion Management

- Previous concussion history
- # of concussions
- Proximity
- Severity of concussions
- Neurological examination
  - Cognition, balance testing, neuropsychological testing
- CT/MRI as indicated

Return-to-Play (RTP) Decisions

- Difficult, controversial
- Special circumstances of the young athletes
  - More at-risk,
    - Slower recovery,
    - Greater long-term consequences,
    - Greater risk of catastrophic re-injury (SIS)
- “When in doubt, sit them out”
Same-day RTP

- Athletes with persisting signs and symptoms or any duration of amnesia should not RTP
- All signs and symptoms must be cleared at rest and with exertion before the athlete is returned to play
RTP After Removal From Sport

- High likelihood that HS athlete removed from play will not play again next Friday night!

- McCrea, collegiate athletes
  - Symptom resolution 7 days
  - Cognitive function 5-7 days
  - Balance deficit 3-5 days
  - 10% had sx$s$ $>$ 7 days
Student-athletes should not return to play until all symptoms have resolved, both at rest and during exertion. Many times, that means they will be out for the remainder of that day.

As concussion management continues to evolve with new science, care is becoming more conservative and return-to-play time frames are getting longer.

Coaches should have a game plan that accounts for this change.
Progressive Structured RTP Protocol

- Complete rest (physical and cognitive)
- Gradual progression of activity after symptoms are resolved
  - Low-level activities
  - Progress to higher level and sport-specific skills and noncontact drills
  - Controlled contact
NFSHA’s Progressive Physical Activity Program

- 1. Light aerobic exercise, 5 to 10 minutes on an exercise bike or light jog; no weight lifting, resistance training, or any other exercises.
- 2. Moderate aerobic exercise, 15 to 20 minutes of running at moderate intensity in the gym or on the field without a helmet or other equipment.
- Step 3: Non-contact training drills in full uniform. May begin weightlifting, resistance training, & other exercises.
- Step 4: Full contact practice or training.
- Step 5: Full game play.
Repeated Concussions in the Same Season

- 1\textsuperscript{st} concussion
  - Out for 1-2 weeks (if sx resolve)
- 2\textsuperscript{nd} concussion
  - Out for 4 weeks
- 3\textsuperscript{rd} concussion
  - Out for the season
- Risk of cumulative injury, esp. in the young athlete (high school or younger)
NCAA Concussion video

“Don’t hide it. Report it. Take time to recover.”

- Aimed at athletes, parents and coaches
- Wide range of sports, both genders, real-life experiences
- No loss of consciousness (neg. LOC)
- Sideline evaluation, remove from play
- Time to heal varies with each athlete
  - ~90% within one week, but 10% not
- Physical rest and academic rest
- Return to Play => no longer having symptoms
  - Danger of persistent symptoms if athlete returns too soon
- Noted concussion researchers: K Guskiewicz, M Putukian, R Cantu
NCAA Concussion Video
Second Impact Syndrome (SIS)

- Catastrophic injury when young athlete resumes contact sports while still symptomatic from recent concussion
- Cases reported in:
  - Hockey, skiing, boxing, contact/collision sports
- All cases [except boxing] involved athletes <= 19 y/o
Second Impact Syndrome (SIS)

- Loss of autoregulation brain vascularity
- => vascular engorgement
- Incr’d intracranial pressure
- Herniation thru foramen magnum
  - Coma, loss of eye movement
  - Respiratory arrest
- Time from 2nd impact to brainstem failure: 2-5 min.
Clinical Presentation

- Second blow to head may be trivial
- Athlete stunned, no loss of consciousness
- Athlete remains standing 15-60 sec.
- Catastrophic injury
  - Precipitous collapse
  - Semicomatose
  - Rapidly dilating pupils, loss of eye movement
  - Respiratory arrest
Prevention

- Concussions cannot be completely prevented
- Concussion history during preparticipation evaluation
- Helmet use decreases the incidence of skull fracture and major head trauma, but does not prevent, and may actually increase, the incidence of concussion
- Enforce rules to limit concussion (e.g., spearing, head-to-head contact, leading with the head)

UIL Website

- NFHS Concussion Management Guidelines
- Return to Play Form – Concussion Management Protocol
- Texas Education Code, Section 38.159, Immunity Provisions
- Requirement for Supervision of the Concussion Management Protocol Program
- Concussion Acknowledgement Form
Designated school official verifies:
- The student has been evaluated by a treating physician selected by the student, their parent or other person with legal authority to make medical decisions for the student.
- The student has completed the Return to Play protocol established by the school district Concussion Oversight Team.
- The school has received a written statement from the treating physician indicating, that in the physician’s professional judgment, it is safe for the student to return to play.
UIL cont’d

- Concussion Training Requirements of Texas Education Code, Section 38.158
- HB 2038 [includes] training requirements for coaches, athletic trainers and potential members of a Concussion Oversight Team in the subject matter of concussions, including evaluation, prevention, symptoms, risks, and long-term effects.
UIL Protocols

- Concussion oversight team
  - MD, nurse, athletic trainer, neuropsychologist, PA
- Removed from competition immediately
  - Coach, MD, trainer, parent, legal guardian
- Concussion Acknowledgement form
  - Signed by parent
- Concussion Mgmt Return to Play form
  - Signed by school official and parent
- Concussion Mgmt Guidelines from NFSHA’s
Be Prepared…

- Know your athlete
- Baseline cognitive assessment helpful
- Effective communication with coaches, trainers, athletes, parents
- Be prepared to manage an acute injury
- System in place for sidelines evaluation and post-game supervision
- Structured ongoing follow-up and evaluation
- Know the literature…

1. When in doubt, sit them out
2. If no sign of concussion at first exam, sit the athlete for 10-15 minutes and recheck
3. Loss of balance is a sensitive objective sign
1. Return to play guidelines have mostly been based on experience with older adolescents and young adults. In children slower progression is generally warranted.

2. Static neurologic exams often fail to elicit symptoms that arise when dynamic testing or exertional testing are used.

3. In children, screen time and harder cognitive tasks should be limited until no symptoms of concussion remain.
Summary

- Sports-related concussion is common,
  - Accounting for 5.5% of all injuries
- Special circumstances of the young athlete
  - Greater risk of injury, slower recovery
- Preseason baseline assessment (ImPaCT)
- Structured Follow-up
- Responsibility to protect young athletes
  - “When in doubt, sit them out”
If you only have time to read one article on concussions:

Resources

- CDC: www.cdc.gov/concussion
- UIL: www.uiltexas.org/health/concussions
- ImPACT (Immed. Post-concussion Assessment & Cognitive Testing) www.impacttest.com/
- Axon sports, Cogstate: www.axonsports.com/index.cfm?pid=2&pageTitle=About-Cogstate