Sports Concussions & School
Kenneth Podell, Ph.D., FACP
Co-director, The Methodist Concussion Center
Conflict of Interest

- Member of NCAA Concussion Task Force  
  - Unpaid
- Consultant to Houston Texans, Astros, Dash, Dynamos and Rice Univ.  
  - Unpaid
- Funding GE/NFL, BrainScope (pending)

Acadia National Park, Bar Harbor, ME
Do the Math: Epidemiology of Sports-Concussions
Do the Math: Epidemiology of Sports-Concussions

- 1.7-3.6 million TBI/yr - CDC
- >350,000 sports concussions per yr (conservative)
  - 225,000 are @ HS level
    - Majority in football
- 15-20% of HS & college football players sustain concussion yearly
- >900 deaths per year from sports and recreational brain injury (all severities)
Not Just for Men

- Higher rate in some sports
- Women have a higher rate of post-concussive sx
  - Also higher baseline rate of symptoms
- Women are 1.7X more likely to have cognitive problems
- Why?
  - Neck strength/head to ball size
  - Physiology – higher blood flow?
HS Gender Comparison

Per 1,000 AEs

<table>
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<tr>
<th></th>
<th>Boys Game</th>
<th>Girls Game</th>
<th>Boys Practice</th>
<th>Girls Practice</th>
</tr>
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<tbody>
<tr>
<td>Same Sport</td>
<td>2.8</td>
<td>4.7</td>
<td>0.3</td>
<td>0.5</td>
</tr>
<tr>
<td>Total</td>
<td>8.2</td>
<td>4.1</td>
<td>1.4</td>
<td>0.7</td>
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Boys Game
Girls Game
Boys Practice
Girls Practice
Dx Concussions in The NHL

Per 100 Games

[Data table]

Donaldson et al, July 17, 2013, Plos One

Dx Concussions in The NFL by Season

Equivalent of 68.2/100 games
### NCAA Concussion Rates

#### Annual Average of Reported Concussions 2009-2014 Academic Years

<table>
<thead>
<tr>
<th>Division</th>
<th>Rate per 1000 AEs</th>
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<tr>
<td>I</td>
<td>0.30</td>
</tr>
<tr>
<td>II</td>
<td>0.32</td>
</tr>
<tr>
<td>III</td>
<td>0.29</td>
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<td>TOTAL</td>
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AE=Athlete-exposure: 1 athlete's participation in 1 practice or 1 competition
Concussion Rate in HS and College by Sport: Game & Practices Combined Per 1,000 Athletic Exposures

- HS: Nat. Acad. Sci, 2010-12
- College: NCAA 2009-14
Are Concussions Becoming More Frequent?
2001-2009 ER Visits for non-fatal TBI - Rate/100K

62% increase in number of ER visits
57% increase in rate of TBI visits
No increase in hospitalizations or brain

http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6039a1.htm?s_cid=mm6039a1_w

ED visit rate ↑ 2.2X following state law –brain CTs no change – in Rhode Island
Concussion State Laws – from 0 to 50 in 5 years

- Washington State 2009
  - Zackery Lystedt Law
  - Oregon 1 month later

- 2010 - NFL commissioner writes states without laws

- 2014 - MS last state

- Common Theme
  - Educate
  - Remove
  - Evaluate & Tx before return
Are Concussions More Frequent or Better Reported?

• Signal Detection Issue?
  – Definition has changed
  – More awareness
  – Better at detecting
  – Better tools to diagnose
  – State Laws
What Is A Concussion?

- Biomechanically induced alteration in metabolic brain functions.
  - Translational energy
  - Acceleration/Deceleration
  - Coupe/contra-couple
  - Torque
- Results in rapid onset of short-lived neurological sx's that remit spontaneously.
- Graded set of sx's with or without LOC.
  - 90% without LOC
- Usually negative imaging & neurologic exam.
Acceleration/Deceleration
Acceleration/Deceleration Concussion
What’s Going On Inside the Head?

• An acute chemical imbalance of the brain.

• Mismatch in energy supply & demand and delivery causes energy crisis (the concussion)

• Three phases
  – Hyperglycolysis
  – Metabolic depression
  – Recover
State of Vulnerability

• The time between repeat mTBIs is the crucial factor affecting the reversibility of concussion
  – Days 3-5 is critical window
• A second concussion within the temporal window of metabolic vulnerability, severe, “difficult-to-reverse” brain damage can occur.
  – Brain initially protects itself but exhausts itself around 72 hours, is vulnerable for 72 hours, and then seems to recover

Vagnozzi et al. Neurosurg 2007
Signs and Symptoms
Signs, Symptoms & Deficits Following A Sports Concussion

**Somatic**
- H/A
- Nausea
- Vomiting
- Balance
- Dizziness
- Lightheaded
- Drowsiness
- Photophobia
- Phonophobia
- Visual changes

**Sleep Disturbance**
- Too Much
- Too Little
- Multiple Awakening
- Falling Asleep

**Cognitive**
- Mental fogginess
- Mental slowness
- Concentration
- Memory

**Emotional**
- Irritability
- Depression
- Anxiety
- Feeling more emotional
More Than Just The Brain: Whiplash & Inner Ear Injuries

• Head & neck go through rapid and over extension
  – Neck/cervical strain common
  – Common source of residual symptoms – occipital
    • headaches
  – Often over looked
  – Need to watch for vestibular problems
Sports Concussions & Emotional Factors: Tip of The Iceberg

• There is more to it than meets the eye:
  – Withdrawal symptoms
  – Competitiveness & Type “A” personality style
  – Vicarious parents
  – Eating disorders
  – Psychiatric Disorders
    • Depression
    • Anxiety
    • ADHD/LD
Returning An Athlete to Play: No Laughing Matter

Two major potential complications if returning still concussed

- Second Impact Syndrome
- Post-concussion Syndrome
Second Impact Syndrome

Characterized by

- pre-existing head injury (often mild)
- persistent concussive-type symptoms (often under-recognized or denied)
  - Chronic intense H/A most common
- a "second impact" to the head or torso of the athlete.
- Brain swelling
  - Loses its ability to control fluid flow
  - Can be severe enough to herniate
Post-Concussion Syndrome

• Potentially debilitating group of prolonged (>30 days; sometimes permanent) physical, emotional and cognitive sequelae related to multiple concussions (even a single one)
  – No correlation between sx reporting and NP testing
• 10% occurrence rate
• Risk factors for occurring
  – Hx of multiple concussions
  – LOC (OR = 4.15)
  – PTA
  – More severe acute sx
Should I let My Child Play Contact Sports

- Increased risk of dementia from concussions dependent upon genetic factors.
  - Understand the difference of risk of dementia vs CTE
- Do not compare High/middle school to Pros
- Benefits
  - Mental/cognitive
  - Physical
  - Emotional/Social
  - Work ethics/perseverance

Chris Borland – SF 49ers; retired 2015
After a one year (promising career)
Should I let My Child Play Contact Sports

- MVA - leading cause of death for U.S. teens.
- Seven (16 - 19 y.o.) die every day from MVA.
- Per mile driven, teen drivers ages 16 to 19 are 3X more likely than drivers ≥ 20 y.o. to be in a fatal crash.
- Benefits?
Recovery Patterns
Returning An Athlete To Play: Slow and Steady

- Age a critical factor
  - Younger kids take longer
- Standard of care: symptom free & cognitively intact
  - Testing
- Gradual return
  - Exertional testing
    - Intense physical activity too soon slows cognitive recovery
Recovery In High School Athletes

• Recovery period- varies by age
  – HS 5-10 days
  – College 3-5 days
    • 1/5 of college and HS recover in 1 day
  – Pros - unclear

• Recovery in HS takes time
  • 50% recover within one week;
  • 70% by two weeks
  • 15% needed ≥3 weeks.
    – Even after mild con without LOC
  – Issue of brain maturation
  – Remember vulnerability window
  – Emphasize individualized approach
  – Individual recovery patterns.
    • Grading system no longer used
Indicators of Prolonged Recovery

• LOC > 1 min
• PTA, RA
• Prolonged H/A
• >4 Sx
• Prior concussions ≥3
Treatment in Acute Stages

- Rest is best –
  - Allow to sleep
- Conservative H/A tx
  - No aspirin or NSAID first 48 hrs
  - Tylenol ok
  - Rx for more severe or persistent H/A
    - ONB?
- Sleep? Melatonin? Rx?
- Stimulant
- No driving
- Monitor symptoms
  - Some treat early
  - Often resolves in 1 month
- EDUCATE
Treatment in Acute Stages

- Reduce noise and bright lights
- Monitor balance – stairs and bathroom
- Minimize physical and mental activity
- Neck strain
- Not uncommon to keep home for a few days
  - Returning to quickly slows recovery!!!!
  - Write note for school
Concussions and School

- Time off from classes
  - Bright, noisy environment
  - Concentration in classes
    - Math, Physics, Theatre
  - Homework

- Brain dysfunction can linger
  - Back to exercising ≠ back to normal

Reintegrating Back Into Classes Can be Tricky
What Teachers Might See

• Squinting, yawning, distracted, head on desk, irritability
• Poor attention or concentrating
• Problems learning/remembering
• ↑ time to complete tasks/assignments
• Slow thinking, reading, talking
• Difficulty mentally organizing or shifting between tasks
• Poor stress management
• More emotional
• Physical and Mental Fatigue

• Difficulties handling a stimulating school environment (lights, noise, etc.)
• Physical symptoms (headache, nausea, dizziness)
What I might Do

• No School/Keep home
• Half days
• Restrict homework and tests/quizzes
• Remove from extra-curricular activity

• Often through a note to school ATC or nurse
How Can Teachers Help?

- Be alert to concussed student
- Remove from Class
- Work with and support student and school team with a slow reintegration
- Be vigilant to emotional factors
  - Stress fear of failing, depression, over-achieving etc
- Need for IEP or modify existing IEP?

- Be part of the team
  - Student, parents, Teachers, ATC, nurses, Admin. And health-care provider
Red Flags

• Be careful if student has history of ADHD, psychiatric illness, or LD
• High/Over-achieving, type A students
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Subacute Exercising

• Notion of complete rest until asymptomatic is changing
• Evidence accumulating for lite subacute exercising
  – Below level of worsening sx
Rest vs. Low-level Activity in Concussion Recovery

- Complete rest during “acute” stages
- No longer rest until asymptomatic
  - Inactivity increases sx, depression, and anxiety
- “Goldilocks” approach
  - Balancing physical and cognitive activity with sx
Return to Play

The first 10,000 fans got a concussion bobblehead!
## Gradual RTP Protocol

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Is Football More Dangerous Today?
History of Football Safety

- 1888 college allows tackling below waist
  - Protective equipment follows
- In 1905 – Proposal to ban football completely
  - Previous season 18/19 players died and 137 serious brain injuries on the field due to skull fractures or cerebral hemorrhages.
    - British news reported 27 deaths and 147 serious injuries
  - New rules in prof football and NCAA
  - Helmets mandatory: College - 1939; NFL 1943
1952 recommendation to retire from football after three concussions or one with prolonged LOC

“The football fields of our nation have been vast proving ground or laboratory for the study of tragic neurological sequelae of head and neck trauma in man”

Richard Schneider, MD, 1967

Established rule that all contact sports must have physician in attendance
Lesser of Two Evils?

- Did use of facemask make the game more dangerous?
- Some advocate for the removal of helmets from football to reduce use of head injuries
  - Avg number of fatalities from head injuries avg 4/yr
  - down from high of 38
  - 80% reduction in subdural hematomas
- Catch 22?
  - Reduce concussions by removing helmets but increase serious skull & brain injuries

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<th>Year</th>
<th>Direct Football Fatalities – All levels</th>
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<td>1931 - 1965</td>
<td>606 (17.3/yr)</td>
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<tr>
<td>2010</td>
<td>5</td>
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Translational Kinetic Energy

\[ \frac{1}{2}(m \times v^2) \]

Morris “Red” Badgro played offense and defense for the N.Y. Giants and right field for baseball’s St. Louis Browns.

245 lbs.

Alan Page of the Minnesota Vikings remains the only defensive tackle to win the NFL Most Valuable Player Award.

335 lbs.

Haloti Ngata is a starting defensive tackle for the Baltimore Ravens. Despite his size, his 40-yard-dash time is under 5 seconds.

190 lbs.

1927

1967

2006

6'0"

6'4"

6'4"

150 lbs.

1930

Draft Year

2010

Weight Trend

Over the past century, the average weight of a defensive tackle has increased significantly.

350 lbs.

300 lbs.

HOW HARD ARE THE HITS? (force in tons)

0.5

2.4

4.9

8.4

12

Race car turn

30 mph car crash with seat belt

Helmet hit by Morris Badgro

Helmet hit by Haloti Ngata

30 mph car crash without seat belt
Concussion Prevention
Prevention – Techniques and Rules

- Techniques
  - Heads Up Football
Rule Changes

- Worked in past – football quarterback in the grasp
- Spearing in NFL, wedge blocks on kick-offs

NFL Concussion Rate by Percent Kick-off Returns
Hey, pop - I'm going for a bike ride.

Not without your bicycle helmet you're not!

Oh, nonsense, Maude.

I never used a sissy helmet and I turned out just fine.

I never used a sissy helmet and I turned out just fine.

I never used a sissy - mom! It's happening again!
Protective Equipment

- Football helmet – no difference in reconditioned school vs. expensive model
  - Add-ons – controversial
    - Most concussions during games
- Soccer head gear (for concussion)
  - No evidence they are effective
- Mouth Pieces - protect the mouth only
- Accelleromotors
  - How do we use them
  - Notoriously unreliable
Ideas for the Future

• Limited number of contact plays
  – HS football plays both sides of the ball – increased exposure
  – We have pitch count in baseball

• Age appropriate participation
  – When to start tackling in football
  – When to start heading in soccer

• Hit Count?
  – Use of sensors to limit number of impacts at threshold?
    • SLI endorses
Eliminating Concussions in Contact Sports

• Not possible yet, but reduce?
  – Design of brain/skull
  – Why woodpeckers don’t get concussions

• Have to eliminate movement of brain inside helmet and rotation around the neck
Rest vs. Low-level Activity in Concussion Recovery

- Complete rest during “acute” stages
- No longer rest until asymptomatic
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- Sleep? Melatonin? Rx?
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- Monitor symptoms
- Vestibulopathies (balance problem)
  - Some treat early
  - Often resolves in 1 month
- EDUCATE
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• Returning to school is very stressful and even scary for some students
• Most students feel stressed when having to make-up work
• Your child may require specific accommodations
• Be supportive, helpful, and understanding
About the 5 Steps

• Using the 5 Steps will help you accommodate your child’s gradual transition back to school
• Observe changes in your child’s symptoms
• Communicate with your child’s teachers
• Modify and revise educational plan as needed based upon:
  – medical advice
  – school policy
  – student’s personality and pre-existing abilities
• 504?
Things to Remember

• “Goldilocks” - Not too much, not too little
• Be patient
• Remember that your child may be anxious when returning to school
• Know your child’s strengths and weaknesses and incorporate into plan.
• More is not better
  – More tutoring or “help” may not be helpful
    • May increase anxiety
## 5 Steps

<table>
<thead>
<tr>
<th>Step 1: Emphasize Cognitive and Physical Rest</th>
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<tbody>
<tr>
<td>• No physical activity</td>
</tr>
<tr>
<td>• Rest body and brain as much as possible</td>
</tr>
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<td>• May need to stay home from school</td>
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<th>Step 2: Open for Modified Daily Class Schedule</th>
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<tbody>
<tr>
<td>• No participation in PE or physical activity</td>
</tr>
<tr>
<td>• Reduced work load</td>
</tr>
<tr>
<td>• Extra time on exams and assignments</td>
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</tbody>
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<th>Step 3: Possible Return to Full Day of School</th>
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<tbody>
<tr>
<td>• Light physical activity - cleared by a health provider</td>
</tr>
<tr>
<td>• Gradually increase amount of assignments</td>
</tr>
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<td>• Extra time on assignments and exams</td>
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<th>Step 4: Reduction of Accommodations and Return to Moderate Physical Activity</th>
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<tbody>
<tr>
<td>• May engage in moderate physical activity</td>
</tr>
<tr>
<td>• May take tests</td>
</tr>
<tr>
<td>• Should be allowed extra time on exams</td>
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<tr>
<th>Step 5: Full Academic Load</th>
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<tbody>
<tr>
<td>• Physical activity without any restrictions</td>
</tr>
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<td>• Return to school full time without any restrictions</td>
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Co-Director, Houston Methodist Concussion Center
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