Concussion: Update
LA-84 Youth Safety Workshop
Bianca Edison, MD; Anita Hamilton, PhD; Dawnie Nishijima, ATC
Children’s Orthopaedic Center, Keck USC
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Disclosures

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- We do not intend to discuss an unapproved/investigative use of a commercial product/device in the presentation.
Sports - Why Play???

Source: Aspen Institute Project Play 2016
Sports - Why Play???

ACTIVE KIDS DO BETTER IN LIFE
WHAT THE RESEARCH SHOWS ON THE COMPOUNDING BENEFITS

ACTIVE PARENTS ASSOCIATED WITH ACTIVE KIDS

KIDS OF ACTIVE MOMS ARE 2X MORE LIKELY TO BE ACTIVE

1/10 AS LIKELY TO BE OBSESE
UP TO 40% HIGHER TEST SCORES
LESS SMOKING, DRUG USE, PREGNANCY AND RISKY SEX
15% MORE LIKELY TO GO TO COLLEGE
7-8% HIGHER ANNUAL EARNINGS
LOWER HEALTH COSTS
MORE PRODUCTIVE AT WORK
REDUCED RISK OF HEART DISEASE, STROKE, CANCER, DIABETES
INTERGENERATIONAL CYCLE
COMPRESSION OF MORBIDITY
1/3 THE RATE OF DISABILITY

EARLY CHILDHOOD

ADOLESCENCE

ADULTHOOD

Source: Aspen Institute Project Play 2016
More than 46 million children and adolescents participate in organized sports in the US each year.

More than 2.6 million children ages 0-19 are seen and treated in the ER each year for sports and recreation-related injuries.
## Kids In Sports - Injury Epidemiology

<table>
<thead>
<tr>
<th>Sport</th>
<th>Number of Injuries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Football</td>
<td>394,333</td>
</tr>
<tr>
<td>Basketball</td>
<td>389,815</td>
</tr>
<tr>
<td>Soccer</td>
<td>172,356</td>
</tr>
<tr>
<td>Baseball</td>
<td>119,869</td>
</tr>
<tr>
<td>Softball</td>
<td>58,140</td>
</tr>
<tr>
<td>Volleyball</td>
<td>43,185</td>
</tr>
<tr>
<td>Wrestling</td>
<td>40,805</td>
</tr>
<tr>
<td>Cheerleading</td>
<td>38,016</td>
</tr>
<tr>
<td>Gymnastics</td>
<td>28,239</td>
</tr>
<tr>
<td>Track and Field</td>
<td>24,999</td>
</tr>
<tr>
<td>Lacrosse</td>
<td>19,490</td>
</tr>
<tr>
<td>Ice Hockey</td>
<td>12,736</td>
</tr>
<tr>
<td>Tennis</td>
<td>7,512</td>
</tr>
<tr>
<td>Field Hockey</td>
<td>4,382</td>
</tr>
</tbody>
</table>

Number of injuries by sport among children ages 19 and under, 2012

**Source:** SafeKids Worldwide Sports and Recreation Safety Fact Sheet (2013)
Sports Injuries - Concussion
Mild traumatic brain injury (mTBI)
Diagnosed based on presence of symptoms and trauma
*Functional disturbance* rather than structural injury
- Normal neuroimaging (CT/MRI) studies
+/- Loss of Consciousness (LOC)
- 81-92% of concussions in sports DO NOT involve LOC.

Sports Injuries - Concussion
Sports Injuries - Concussion

Sports Risk

- Football
- Ice Hockey
- Wrestling
- Basketball
- Soccer
- Softball
- Field Hockey
- Baseball
- Lacrosse
- Cheer
Sports Injuries - Concussion Symptoms

- Loss of consciousness (even brief)
- Memory difficulties / amnesia
- Photophobia
- Phonophobia
- Hearing changes
- Difficulty concentrating
- Fatigue
- Difficulty sleeping/sleep changes
- Clumsy movements
- Behavior, mood, personality change
- Changes in school performance

- 1 or more symptoms → Suspect concussion
- Onset may be delayed
Sports Injuries - Sideline Assessment

• Observation in practice AND competition by MEDICAL PERSONNEL
  • Immediate removal without return that day:
    • Loss of consciousness
    • Impact seizure
    • Tonic posturing
    • Gross motor instability
    • Confusion/Amnesia
  • Removal for evaluation:
    • Report of symptoms (HA, Nausea, Dizziness, etc)
    • Balance difficulties
    • Having a blank or vacant look

• Initial evaluation
  • History
  • Focused physical exam, including cervical spine
  • If sports-related concussion is suspected, perform a specific concussion assessment
    • Symptom report
    • SCAT-5, Child SCAT-5
**Sports Injuries- Vestibular/Ocular Dysfunction**

- 30-88% of patients seen in concussion clinics report or have findings of vestibular-ocular dysfunction
  - Master et al. CJSM, 2018
  - Ellis et al. JNS Peds 2017
Sports Injuries - Ocular Symptom Simulation

Double Vision
Blurry Vision
Trouble Focusing
Sports Injuries - Concussion

Why the worry??
**Second Impact Syndrome**

- **Supply**
  - ↓ CBF

- **Demand**
  - ↑ Glucose req.
  - Reset Ca/K balance

Cell dysfunction and ↑ vulnerability of the cell to a 2nd insult

Sports Injuries - Concussion/SIS

**RED Flags!**

- Worsening headache
- Sudden weakness
- Vomiting
- Slowed pulse
- Pupil irregularity
Assembly Bill 2127, Formerly Concurrency RTP (49475, AB25) 
APPROVED and signed into Law!

- NO same-day RTP
  - Require a school district that elects to offer athletic programs to immediately remove from a school-sponsored athletic activity for the remainder of the day an athlete who is suspected of sustaining a concussion or head injury during that activity.

- Medical clearance for RTP
  - RTP after written clearance from a licensed health care provider, trained in the management of concussions, acting within the scope of his or her practice.

- Limitations on contact play
  - Prohibit high school and middle school FB teams of school districts, charter, private school that offer an athletic program from conducting more than 2 full-contact practices per week during preseason and regular season; no more than 90 min/day

- Athlete/Parent Education
Sports Injuries - Concussion
Sports Injuries- Management/RTP

Brain Rest → Restful Home Activity → Return to School (Partial Day) → Return to School (Full Day) → Full Recovery

- An athlete should not return to contact sport play until s/he is fully recovered
  - Resolution of symptoms
  - Tolerating school
  - Full return of energy levels
  - Tolerating higher level non-contact activity

<table>
<thead>
<tr>
<th>Table 5</th>
<th>Return to sport</th>
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</thead>
<tbody>
<tr>
<td>Stage</td>
<td>Description</td>
</tr>
<tr>
<td>1</td>
<td>Symptom-limited activity</td>
</tr>
<tr>
<td>2</td>
<td>Light aerobic exercise</td>
</tr>
<tr>
<td>3</td>
<td>Sport-specific exercise</td>
</tr>
<tr>
<td>4</td>
<td>Non-contact training drills</td>
</tr>
<tr>
<td>5</td>
<td>Full contact practice</td>
</tr>
<tr>
<td>6</td>
<td>Return to sport</td>
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Sports Injuries- Concussion Research

Figure. Timeline of Notable Publications and Events in the History of Repetitive Brain Trauma Research Advancing the Understanding of Neuropathological and Clinical Outcomes

1928: Marland describes "Punch Drunk" clinical syndrome in retired boxers
1933: Parker publishes "Traumatic Encephalopathy ("Punch Drunk") of Professional Pugilists"
1940: Bowman and Blau first use "chronic traumatic encephalopathy" to describe persistent symptoms in a retired boxer
1949 and 1957: Critchley describes "chronic traumatic encephalopathy of boxers"
1954: Brandenburg and Hallervorden first characterize AD-like pathology in former boxer case study
1973: Corsellis et al describe neuropathologic findings of DP as abnormal NFT deposition without plaques in brains of 15 retired boxers
1990: Roberts et al reexamine brains from Corsellis et al with new staining technique and report presence of AD-like senile plaques
1999: Geddes et al note neocortical NFTs around blood vessels in young cohort with multiple mTBI
1969: Roberts reports on nervous system lesions in sample of 37 retired boxers
1940: Millsap describes symptomatic symptoms of retired boxers
1928: Millsap coins term Dementia Pugilistica describing symptomatic symptoms of retired boxers

2000-2004
2005-2009
2010-2013
2014-2016
2017

2005 and 2007: Guskiewicz et al report correlations between concussion history, MCI, and depression

2010-Present: Incorporation of advanced neuroimaging (eg, PET, DTT) and fluid biomarkers (eg, plasma, serum, and CSF-tau) to develop science of in vivo detection and clinical correlates of CTE with mixed results to date. Clinical trials ongoing.

Criteria for pathologic diagnosis of CTE published from NINDS/NIBIB consensus meeting
2013-2016: Several diagnostic criteria are proposed for clinical symptoms of CTE, or "Traumatic Encephalopathy Syndrome"
Head Injury- What do we know now: Biomarkers?

- Limited indications for neuroimaging (CT/MRI)
- Fluid biomarkers (blood, saliva, cerebrospinal fluid) is under active research evaluation
  - FDA recently approved blood test looking at certain proteins to rule out intracranial bleed/structural damage in traumatic head injury- NO use at this time in diagnosis or management of concussion
- No current role for genetic testing in management of SRC
Sports Injuries - Concussion - Research

Head Injury - What do we know now: Short-term risks after concussion or premature RTP?

• Premature return to contact play or continuing to play in the setting of concussion carries risk
  – Increased symptoms
  – Worsened injury
  – Prolonged recovery
  – Increased risk of repeat concussion injury
  – Increased risk of lower extremity musculoskeletal injury

• Exercise: light aerobic activity as tolerated is associated with faster recovery.
Several studies have reported possible relation of professional and collegiate football play with depression
- Risk of mental health issues, including suicide, among formal NFL players is lower than age-matched controls
- Formal high school football players show no difference in cognitive function testing and have been found to have lower depression scores when compared with non-contact sport controls

Sport and exercise have been found to be protective against risk of depression

Mental health issues are common, and are being found to affect younger populations more and more
- Those issues are multifactorial
- Often present independent of participation in contact or collision sport
- Need further longitudinal research to assess long-term risks
Head Injury - What do we know now: Long-term risks of concussion with relation to CTE?

- 2810 lay press articles published from 2014-2018 regarding CTE
  - Daunting task to sift through the information and evaluate the risk-benefit ratio of participation in sports

Question of how extensive the sampling must be to “rule out” CTE was discussed but no data were available to make determination
  - What is the correlation of tau found and clinical symptoms?
Head Injury- What do we know now: Long-term risks of concussion with relation to CTE?

- 177/202 Brains (87%) found to have CTE
  - 110/111 former NFL
  - 7/8 former CFL
  - 9/14 formal semiprofessional
  - 48/53 former college
  - 3/14 high school
  - 0/2 pre high school
Head Injury - What do we know now: Long-term risks of concussion with relation to CTE?

- 26 former NFL players vs. 31 control individuals
  - Experimental scans revealed higher level of protein that can be tied to CTE, mean SUVR higher among former players in 3 areas of the brain
  - No association between tau deposition and scores on cognitive/neuropsych testing
  - Controls were not asked re: contact sport participation in life
Head Injury - What do we know now: Long-term risks of concussion with relation to CTE?

**CONCLUSIONS AND RELEVANCE** Cognitive and depression outcomes later in life were found to be similar for high school football players and their nonplaying counterparts from mid-1950s in Wisconsin. The risks of playing football today might be different than in the 1950s, but for current athletes, this study provides information on the risk of playing sports today that have a similar risk of head trauma as high school football played in the 1950s.
Head Injury - What do we know now: Long-term risks of concussion with relation to CTE?

- Question of association vs causation
  - Research to date points to association of CTE and tackle football
  - Unclear how much is too much
  - Not unique to football sport
  - Still establishing pathological diagnosis - need for consistency
  - Further need for research to assess correlation with pathologic findings and clinical presentation
  - Can there be pre-mortem identification and treatment?
Repetitive impacts to the head over one season may negatively impact learning in some collegiate athletes. Further research is needed to ascertain whether those effects are short term or persistent.
Can helmet sensors be used to diagnose and monitor concussion risk exposure?

- No measurement of force or angular acceleration exposure can be used to diagnose concussion
- Variable response to levels of force exposure
- Current measures are poor predictors of SRC
Sports Injuries- Concussion Myth Busters

Can helmets or mouth guards prevent concussion?
Can any supplements help with concussion recovery?

**Effect of Docosahexaenoic Acid on a Biomarker of Head Trauma in American Football**

Oliver, JM; Jones, MT; Kirk, KM; Gable, DA; Repshas, JT; Johnson, TA; Andreasson, U; ... Zetterberg, H; [view all](http://example.com)


- Omega-3 Fatty acids (DHA - docosahexaenoic acid)
  - Favorable results in rat models
Examples of organizations with concussion-safety guidelines

U.S. Soccer Concussion Initiative 2016

- Substitution rule changes
- Heading changes
Sports Injuries- Concussion Best Practices

Examples of organizations with concussion-safety guidelines

USA Hockey

- Signs and symptoms to observe
- Action Plan
- Rules/regulation changes on body checking
Sports Injuries- Concussion Best Practices

Examples of organizations with concussion-safety guidelines

US Lacrosse
- Signs and symptoms to observe
- Action plan
- Research study on effect of headgear in female players
- Cross/Body check rules
Sports Injuries

Thank You!
Questions?
Sports Injuries - Concussion References

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• Meehan WP, Bachur RG, “Sport-Related Concussion” *Pediatrics*;123;114-123, 2009


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