USC University of Southern California

Concussion: Update

LA-84 Youth Safety Workshop

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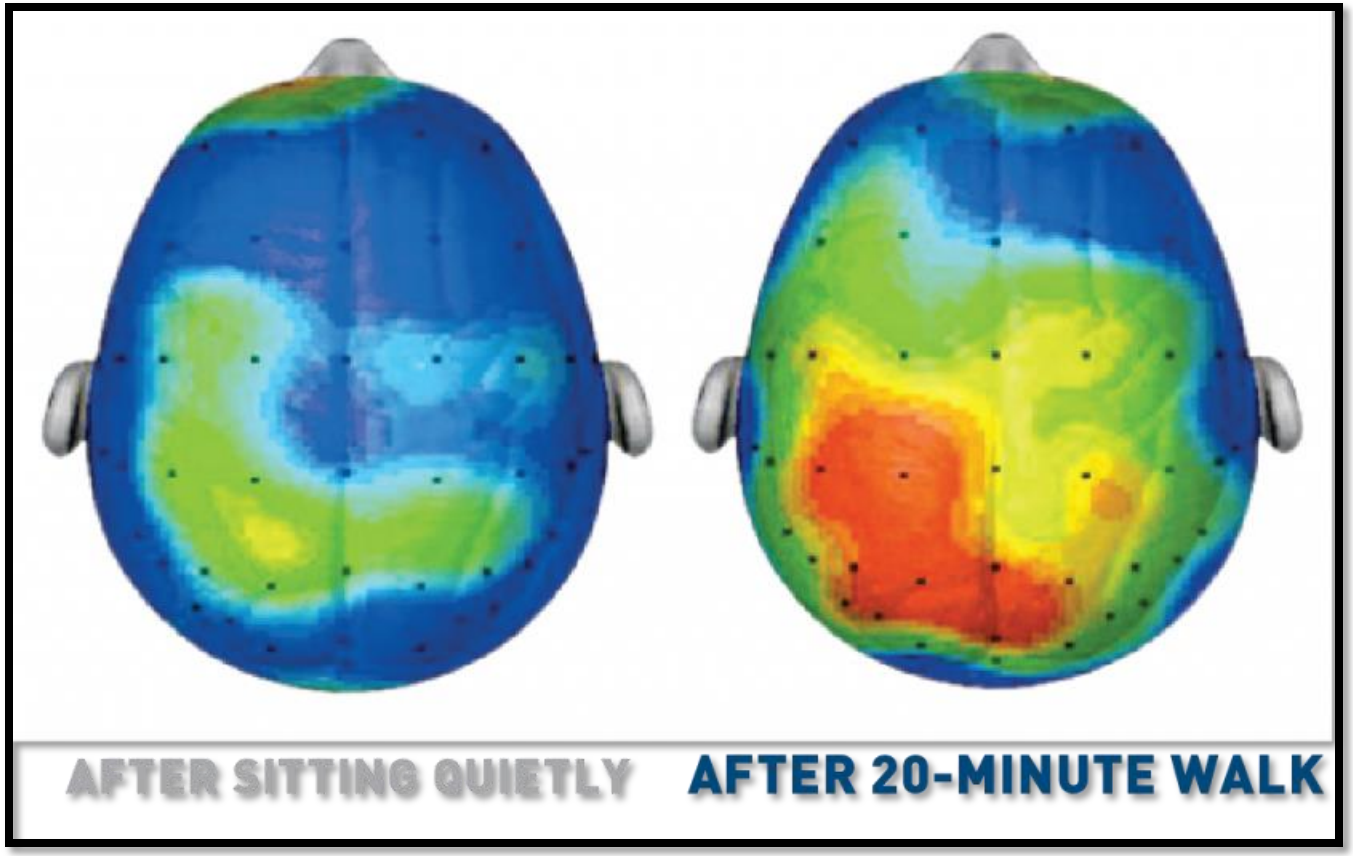
Disclosures

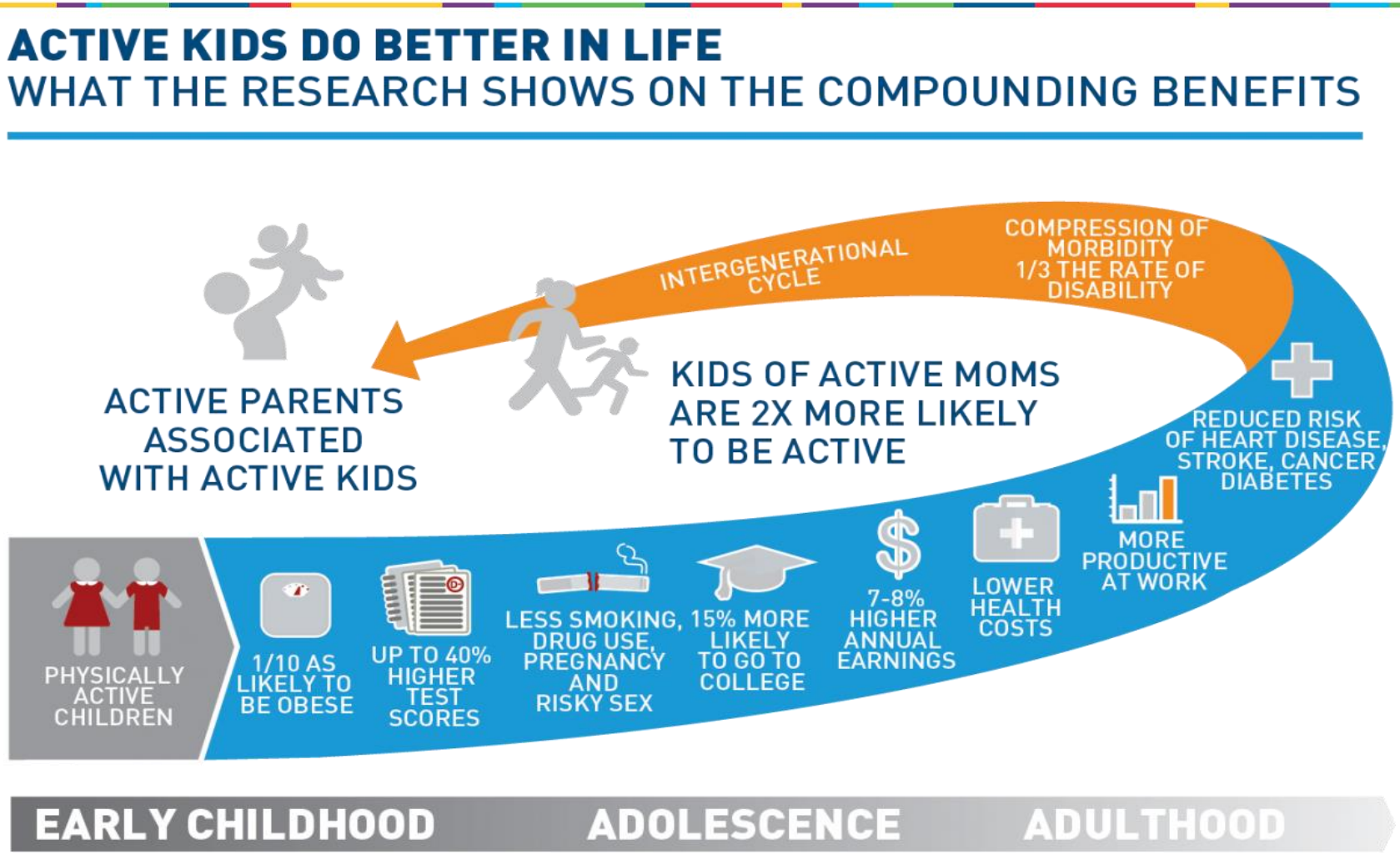
- *We have no relevant financial relationships with the manufacturer(s) of any commercial product(s) and/or provider(s) of commercial services discussed in this CME activity*
- *We do not intend to discuss an unapproved/investigative use of a commercial product/device in the presentation*

Sports- Why Play???



Source: Aspen Institute Project Play 2016

Sports- Why Play???



Source: Aspen Institute Project Play 2016

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Epidemiology- Sports Injury in Youth

- 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

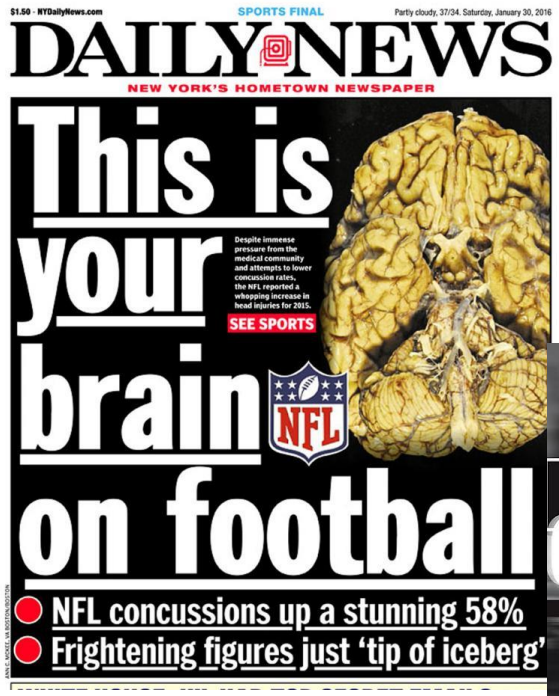
Kids In Sports- Injury Epidemiology

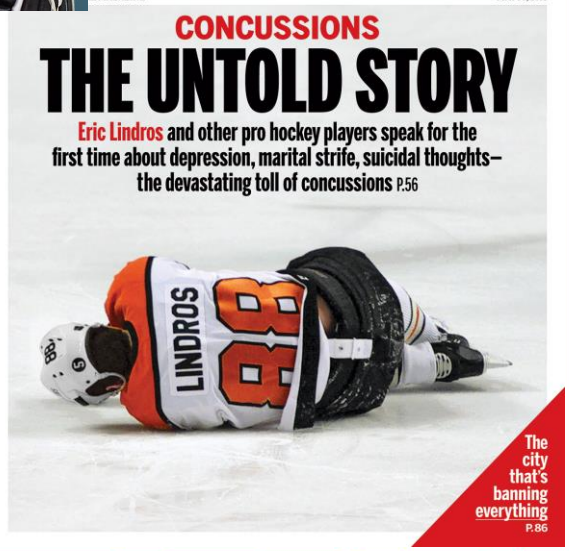
Sport	Number of Injuries
Football	394,333
Basketball	389,815
Soccer	172,356
Baseball	119,869
Softball	58,140
Volleyball	43,185
Wrestling	40,805
Cheerleading	38,016
Gymnastics	28,239
Track and Field	24,999
Lacrosse	19,490
Ice Hockey	12,736
Tennis	7,512
Field Hockey	4,382

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





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Sports Injuries- Concussion

"Ding"

"Bell Rung"

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.

[Shultz, *Am J Epidemiol*, 2004; Collins, *Clin J Sports Med*, 2003]

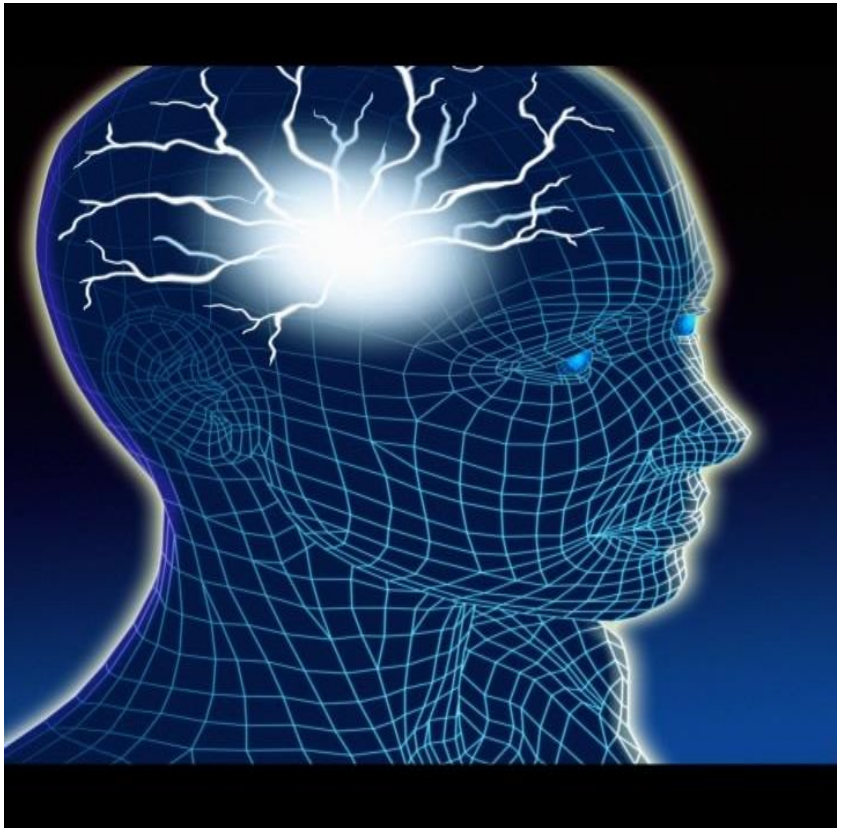
Sports Injuries- Concussion

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

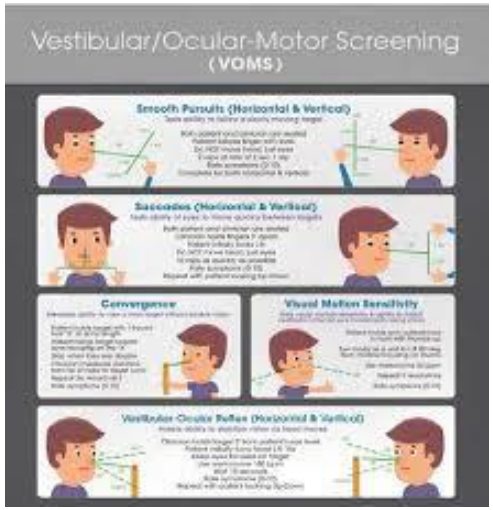
- 1 or more symptoms→ Suspect concussion
- Onset may be delayed

Sports Injuries- Sideline Assessment

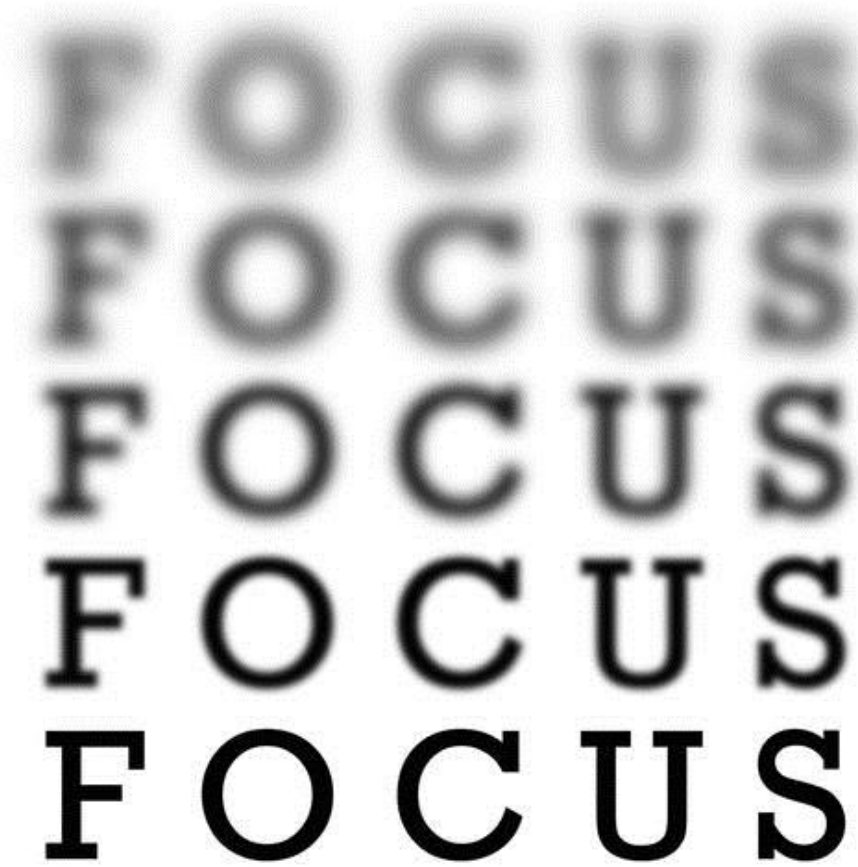
- Observation in practice AND competition by MEDICAL PERSONNEL
  - Immediate removal without return that day:
    - Loss of consciousness
    - Impact seizure
    - Tonic posturing
    - Gross motor instability
    - Confusion/Amnesia
  - Removal for evaluation:
    - Report of symptoms (HA, Nausea, 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

Why the worry??

Sports Injuries- Concussion/SIS

Second Impact Syndrome

Supply
- ↓ CBF

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

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

Source: Giza CC, Hovda DA. Ionic and metabolic consequences of concussion. In: Cantu RC, Cantu RI. *Neurologic Athletic and Spine Injuries*. St Louis, MO: WB Saunders Co; 2000:80-100

Sports Injuries- Concussion/SIS

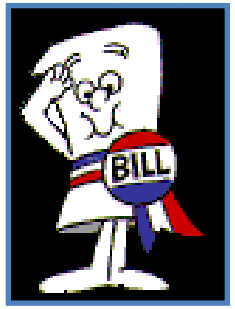
RED Flags!

- Worsening headache
- Sudden weakness
- Vomiting
- Slowed pulse
- Pupil irregularity

Sports Injuries- Concussion/SIS

Assembly Bill 2127, Formerly Concussion 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

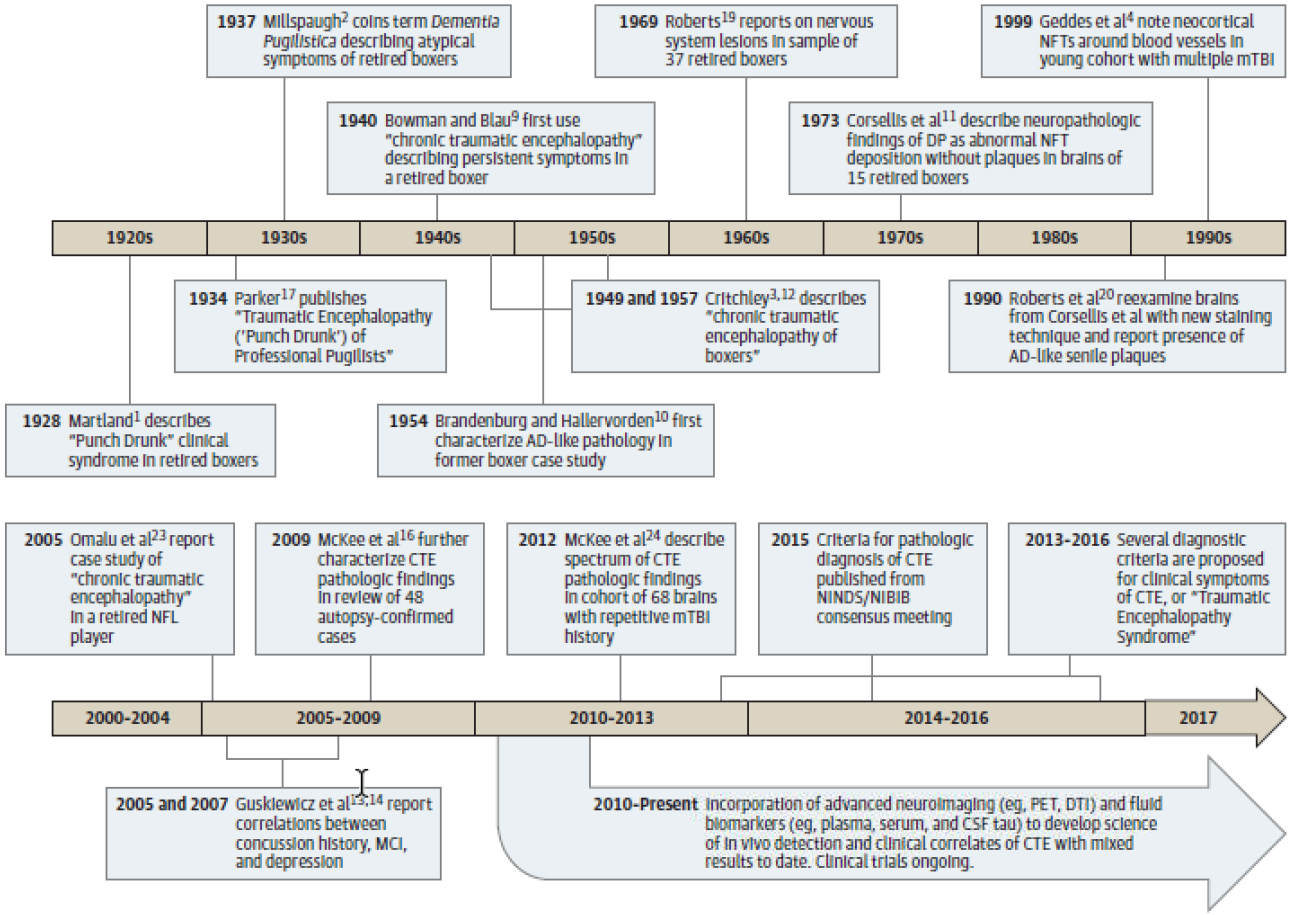
Table 5 Return to sport

Stage	Description	Objective
1	Symptom-limited activity	Reintroduction of normal activities of daily living. Symptoms should not worsen with activity.
2	Light aerobic exercise	Walking, stationary biking, controlled activities that increase heart rate.
3	Sport-specific exercise	Running, skating or other sport-specific aerobic exercise avoiding risk of head impact.
4	Non-contact training drills	Sport-specific, non-contact training drills that involve increased coordination and thinking. Progressive introduction of resistance training.
5	Full contact practice	Return to normal training activities. Assess psychological readiness.
6	Return to sport	

Sports Injuries- Concussion Recognition

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



Sports Injuries- Concussion - Research

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.

Sports Injuries- Concussion - Research

Head Injury- What do we know now: Long-term risks of concussion with mental health/depression?

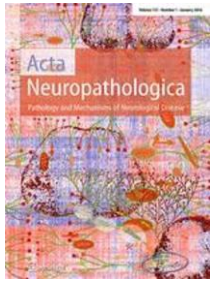
- Several studies have reported possible relation of professional and collegiate football play with depression
  - Risk of mental health issues, including suicide, among formal NFL players is lower than age-matched controls
  - Formal high school football players show no difference in cognitive function 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

Sports Injuries- Concussion - Research

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

CONSENSUS PAPER



The first NINDS/NIBIB consensus meeting to define neuropathological criteria for the diagnosis of chronic traumatic encephalopathy

Ann C. McKee[1,2,3,4,5] · Nigel J. Cairns[6] · Dennis W. Dickson[7] · Rebecca D. Folkerth[8] · C. Dirk Keene[9] · Irene Litvan[10] · Daniel P. Perl[11] · Thor D. Stein[2,3,4,5] · Jean-Paul Vonsattel[12] · William Stewart[13] · Yorghos Tripodis[3,14] · John F. Crary[15] · Kevin F. Bieniek[7] · Kristen Dams-O'Connor[16] · Victor E. Alvarez[1,2,3,4] · Wayne A. Gordon[16] · the TBI/CTE group

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?

Sports Injuries- Concussion - Research

Head Injury- What do we know now: Long-term risks of concussion with relation to CTE?

JAMA | Original Investigation

Clinicopathological Evaluation of Chronic Traumatic Encephalopathy in Players of American Football

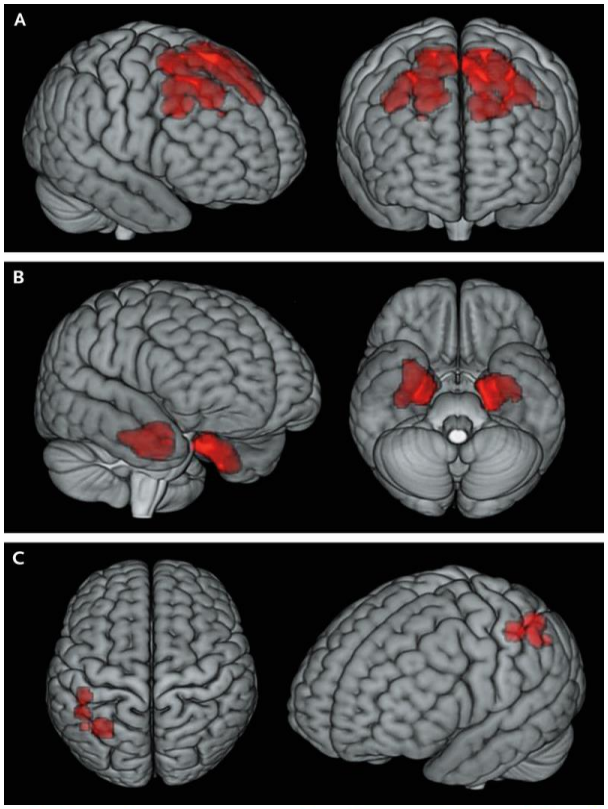
Jesse Mez, MD, MS; Daniel H. Daneshvar, MD, PhD; Patrick T. Kiernan, BA; Bobak Abdolmohammadi, BA; Victor E. Alvarez, MD; Bertrand R. Huber, MD, PhD; Michael L. Alosco, PhD; Todd M. Solomon, PhD; Christopher J. Nowinski, PhD; Lisa McHale, EdS; Kerry A. Cormier, BA; Caroline A. Kubilus; Brett M. Martin, MS; Lauren Murphy, MBA; Christine M. Baugh, MPH; Phillip H. Montenigro, BA; Christine E. Chaisson, MPH; Yorghos Tripodis, PhD; Neil W. Kowall, MD; Jennifer Weuve, MPH, ScD; Michael D. McClean, ScD; Robert C. Cantu, MD; Lee E. Goldstein, MD, PhD; Douglas I. Katz, MD; Robert A. Stern, PhD; Thor D. Stein, MD, PhD; Ann C. McKee, MD

- 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

Sports Injuries- Concussion - Research

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



Sports Injuries- Concussion - Research

Head Injury- What do we know now: Long-term risks of concussion with relation to CTE?

JAMA Neurology | Original Investigation

Association of Playing High School Football With Cognition and Mental Health Later in Life

Sameer K. Deshpande, BS; Raiden B. Hasegawa, BA; Amanda R. Rabinowitz, PhD; John Whyte, MD, PhD; Carol L. Roan, PhD; Andrew Tabatabaei; Michael Baiocchi, PhD; Jason H. Karlawish, MD; Christina L. Master, MD, CAQSM; Dylan S. Small, PhD

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.

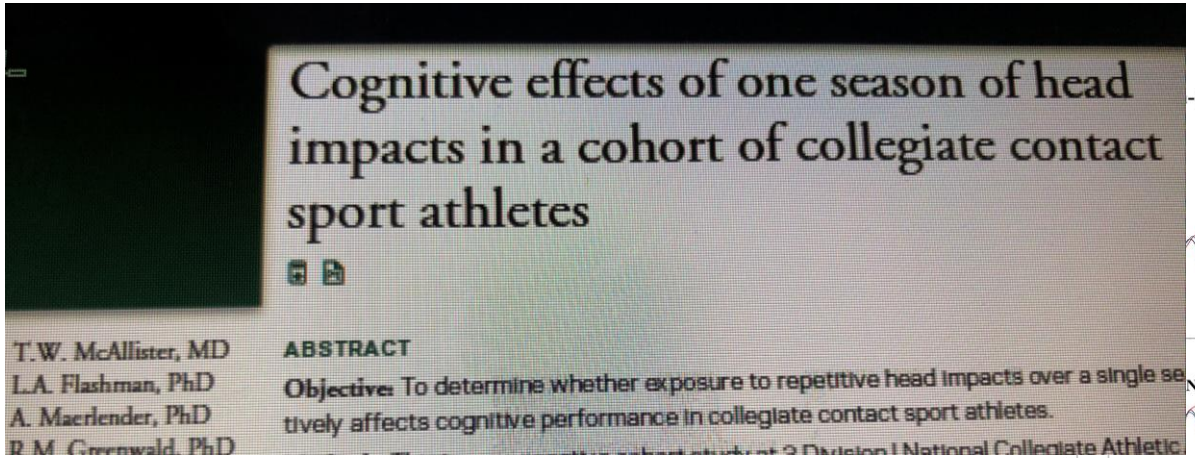
Sports Injuries- Concussion - Research

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?

Sports Injuries- Concussion - Research

Head Injury- What do we know now: subconcussive impact effects?

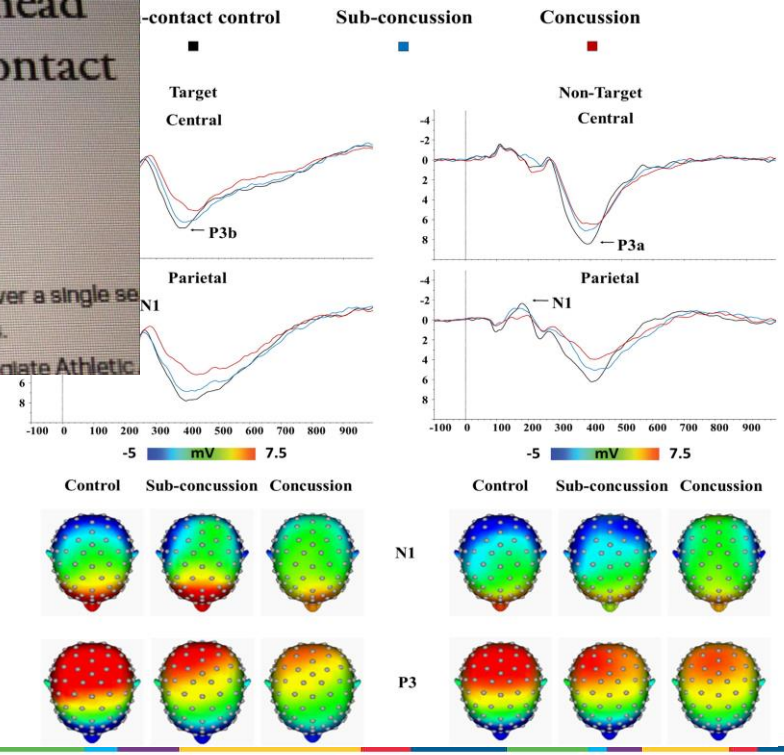


Cognitive effects of one season of head impacts in a cohort of collegiate contact sport athletes

T.W. McAllister, MD
L.A. Flashman, PhD
A. Maerlender, PhD
R.M. Greenwald, PhD

ABSTRACT

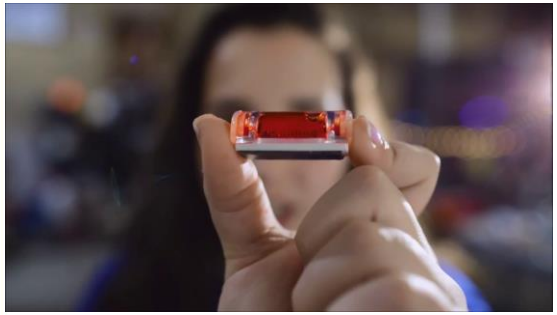
Objective: To determine whether exposure to repetitive head impacts over a single se tively affects cognitive performance in collegiate contact sport athletes.



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.

Sports Injuries- Concussion Myth Busters

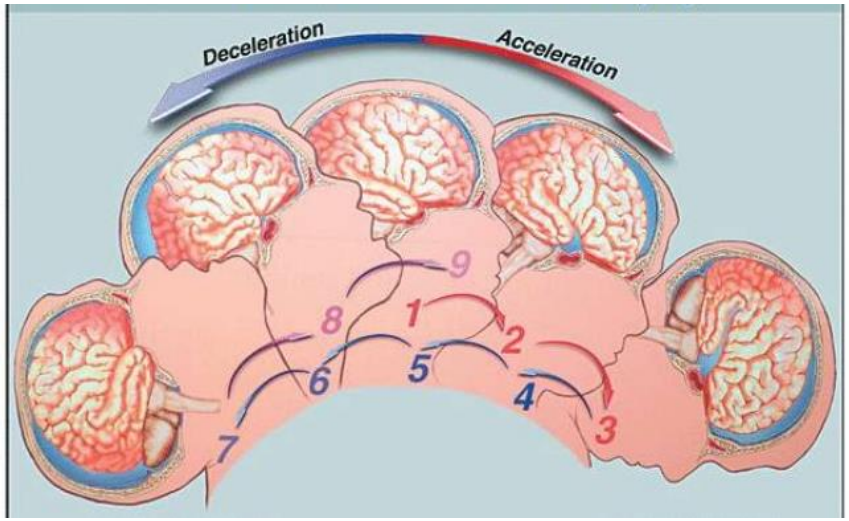
Can helmet sensors be used to diagnose and monitor concussion risk exposure?



- 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?



Sports Injuries- Concussion Myth Busters

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 (2016) Effect of Docosahexaenoic Acid on a Biomarker of Head Trauma in American Football. **Medicine & Science in Sports & Exercise** , 48 (6) pp. 974-982. 10.1249/MSS.0000000000000875.

- Omega-3 Fatty acids (DHA – docosahexaenoic acid)
  - Favorable results in rat models

Sports Injuries- Concussion Best Practices

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

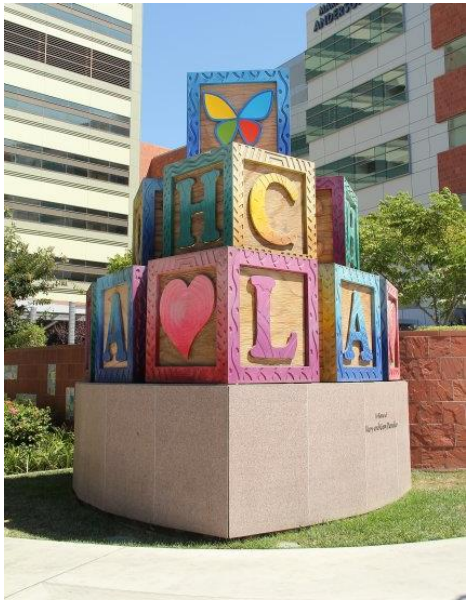
Sports Injuries- Concussion Best Practices

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?

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