



MedStar
Sports Medicine

Knowledge and Compassion
Focused on You

June 5, 2018

Concussions, CTE, and Sport Participation: Where are we heading?

Innovations in Translating Injury Research into Effective Prevention
Center for Injury Epidemiology and Prevention at Columbia

Andrew Lincoln, ScD, MS

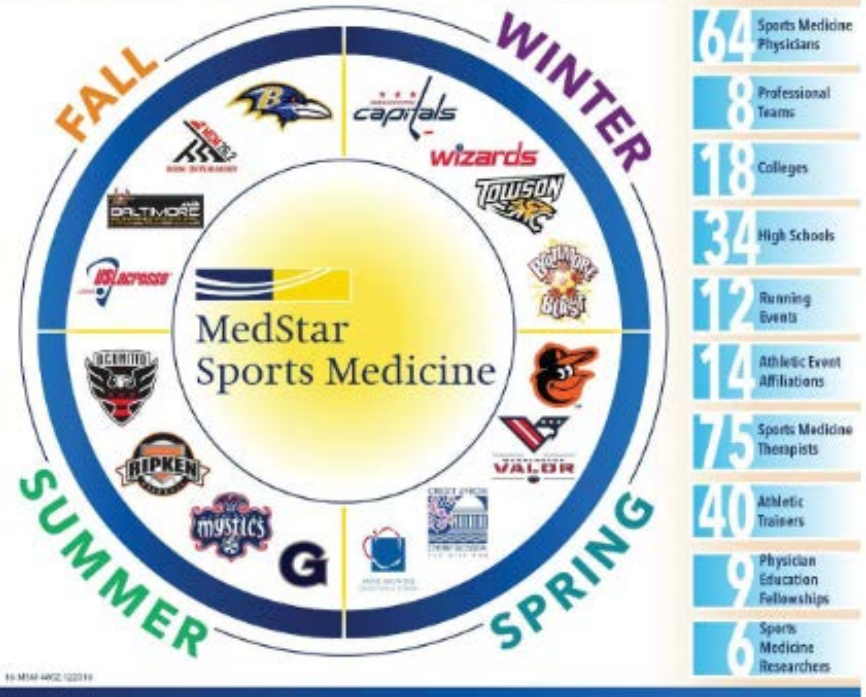
Disclosures

I have no relevant financial relationships to be discussed, directly or indirectly, referred to or illustrated with or without recognition within the presentation.

Greetings from the MedStar Sports Medicine Research Center



ALL ATHLETES ... ALL SEASONS



- Lisa Hepburn, PhD
- Kezia Alexander, MPH
- Reginald Dunn, MS
- Tom Goglia, MBA

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MedStar Health
Research Institute



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Agenda

- Definitions: Concussion & CTE
- Current state of understanding
- Primary prevention approaches
- Disconnect between science & media
- Effects on sport participation, legislation & rule changes
- New directions

Concussion:

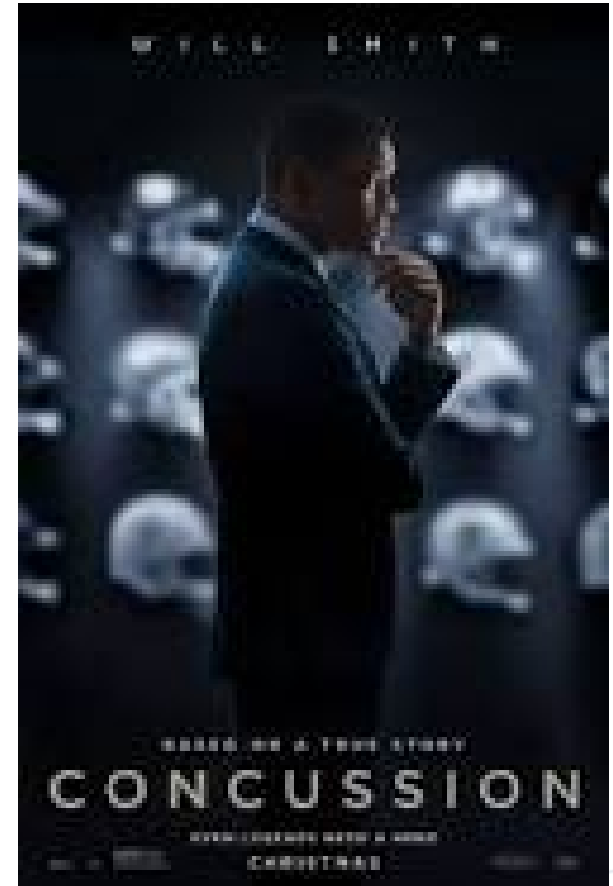
- A concussion is a type of traumatic brain injury—or TBI—caused by a bump, blow, or jolt to the head or by a hit to the body that causes the head and brain to move rapidly back and forth. This sudden movement can cause the brain to bounce around or twist in the skull, creating chemical changes in the brain and sometimes stretching and damaging brain cells.
- https://youtu.be/Sno_0Jd8GuA

A unique injury and public health issue



NFL Commissioner Roger Goodell testifies with others before the House Judiciary Committee about brain injuries resulting from football.

Chip Somodevilla/Getty Images

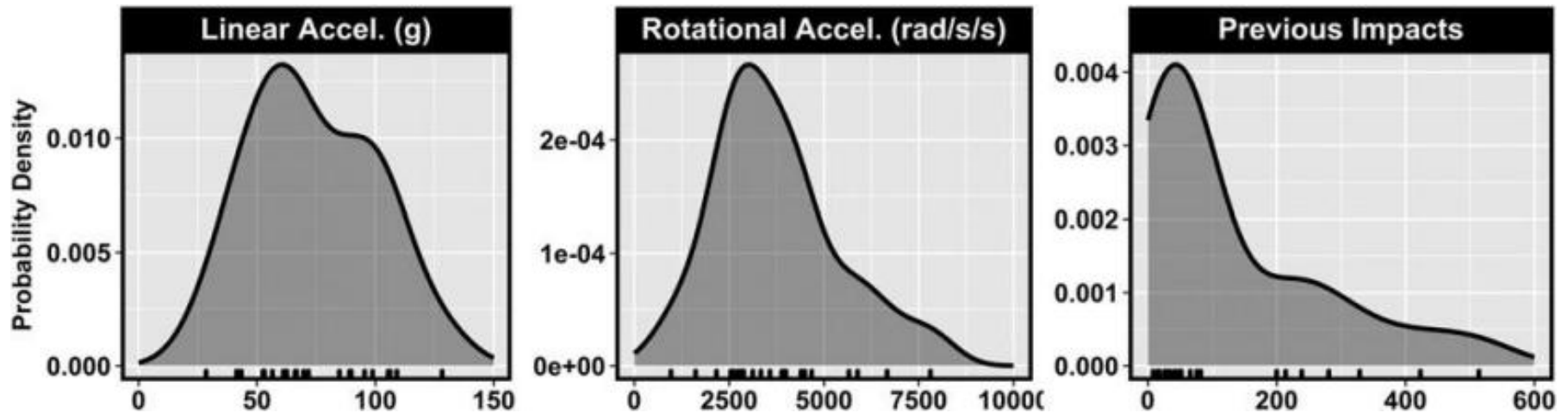


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Correlation of Concussion Symptom Profile with Head Impact Biomechanics: A Case for Individual-Specific Injury Tolerance

Steven Rowson,¹ Stefan M. Duma,¹ Brian D. Stemper,² Alok Shah,² Jason P. Mihalik,³
Jaroslaw Harezlak,⁴ Larry D. Rikken,⁵ Christopher C. Giza,⁶ John P. DiFiori,⁷ Alison Brooks,⁸
Kevin Guskiewicz,³ Darren Campbell,⁹ Gerald McGinty,⁹ Steven J. Svoboda,¹⁰
Kenneth L. Cameron,¹⁰ Steven P. Broglio,¹¹ Thomas W. McAllister,¹² and Michael McCrea²



Biomechanical measures associated with injury were not found to be correlated with number of symptoms, Sport Concussion Assessment Tool 3 Symptom Severity Score, or time to symptom resolution... While concussive impacts did not stand out relative to impacts that did not result in injury, concussive impacts were among the most severe for each individual player. This suggests tolerance to head acceleration might be individual-specific, meaning similar biomechanical inputs can produce different injury presentations between individuals.

Benefits of Strict Rest After Acute Concussion: A Randomized Controlled Trial

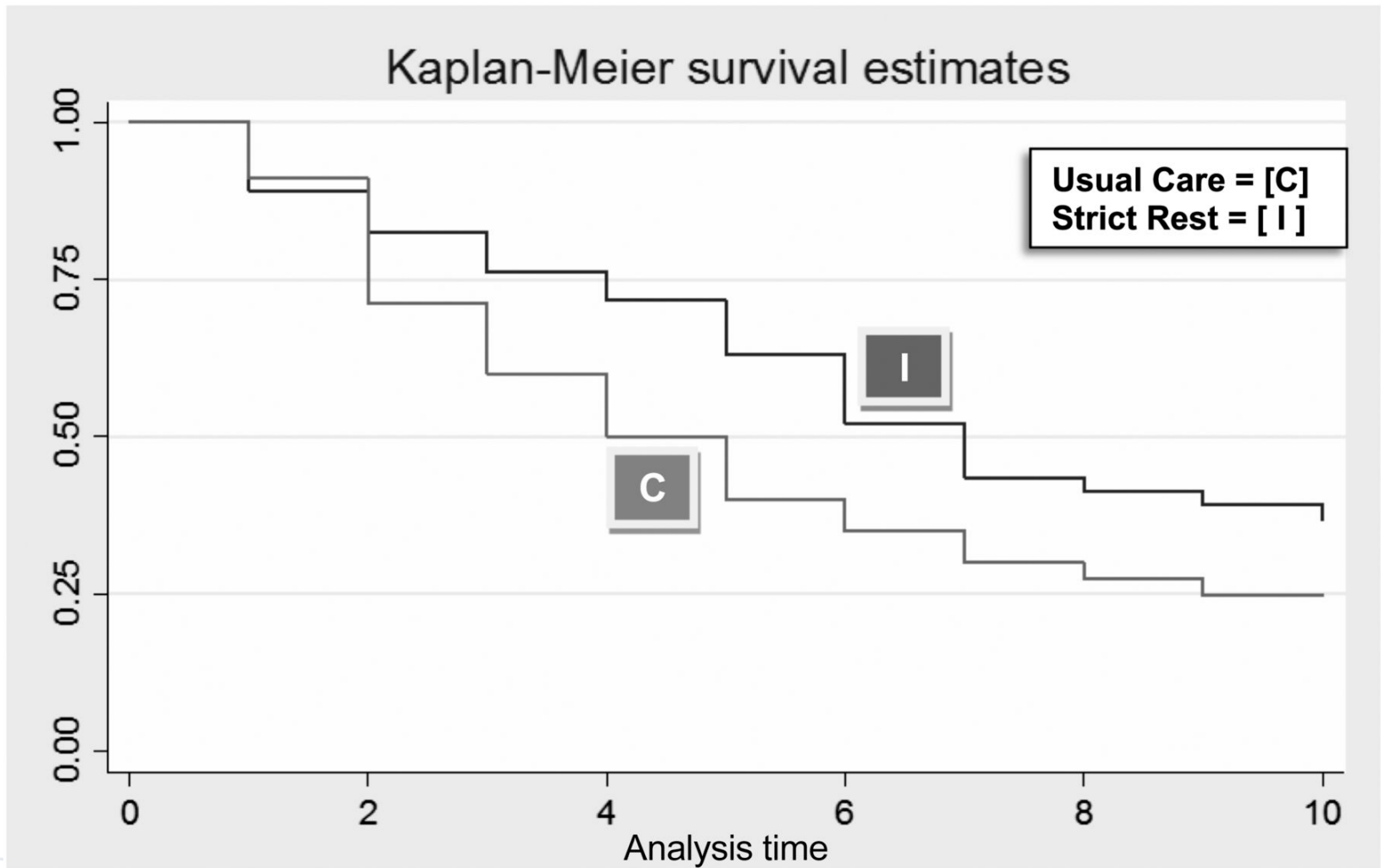
Danny George Thomas, MD, MPH^a, Jennifer N. Apps, PhD^b, Raymond G. Hoffmann, PhD^a, Michael McCrea, PhD^c, Thomas Hammeke, PhD^b

CONCLUSIONS: Recommending strict rest for adolescents immediately after concussion offered no added benefit over the usual care. Adolescents' symptom reporting was influenced by recommending strict rest.

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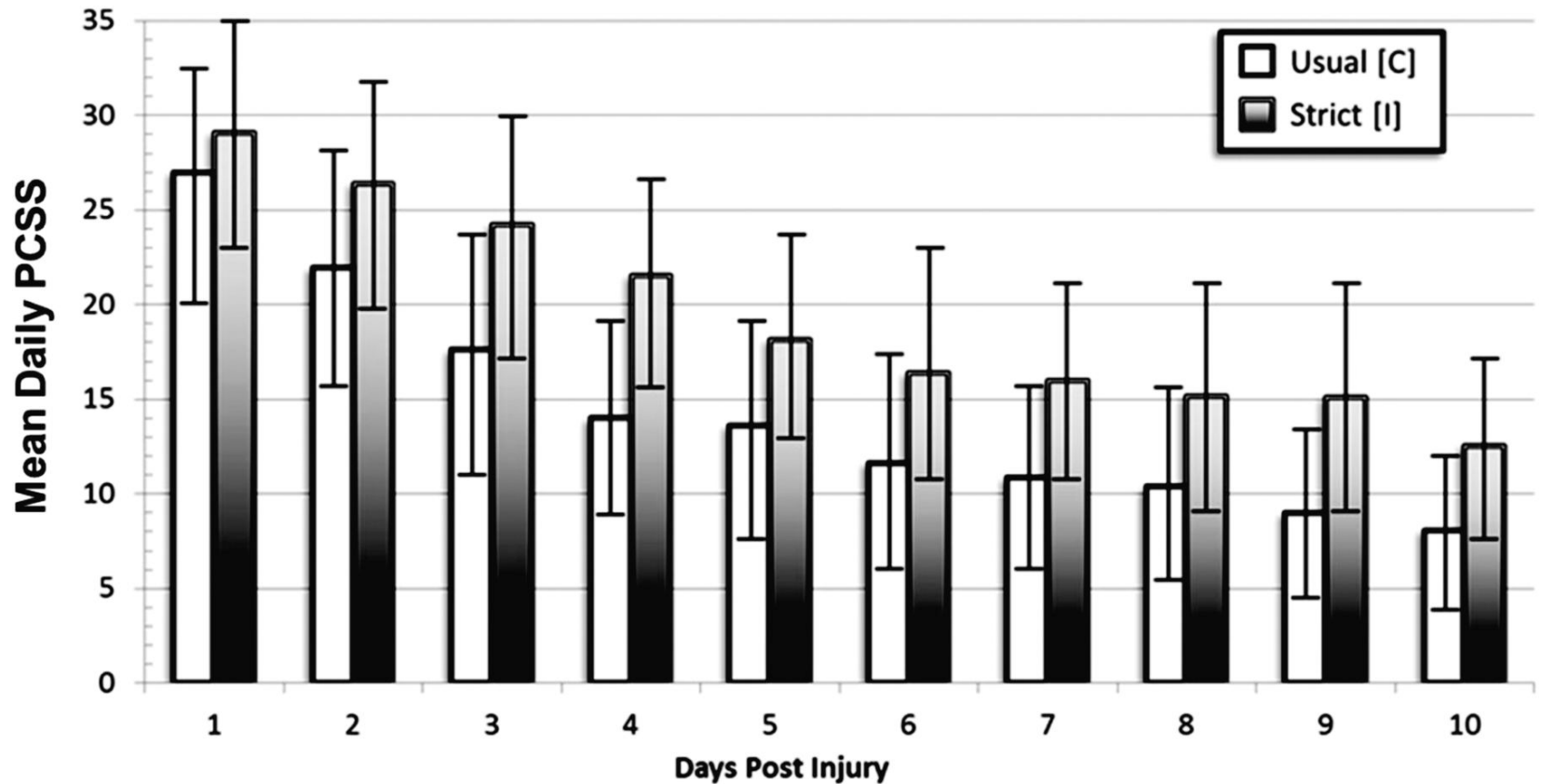
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Proportion of patients reporting symptom resolution (PCSS ≤ 7) over time.



Danny George Thomas et al. Pediatrics 2015;135:213-223

Mean PCSS with 95% confidence interval over time.



Danny George Thomas et al. Pediatrics 2015;135:213-223

Current State of Knowledge on Sport-Related Concussion

Consensus statement

Consensus statement on concussion in sport—the 5th international conference on concussion in sport held in Berlin, October 2016

Paul McCrory,¹ Willem Meeuwisse,² Jiří Dvorak,^{3,4} Mark Aubry,⁵ Julian Bailes,⁶ Steven Broglio,⁷ Robert C Cantu,⁸ David Cassidy,⁹ Ruben J Echemendia,^{10,11} Rudy J Castellani,¹² Gavin A Davis,^{13,14} Richard Ellenbogen,¹⁵ Carolyn Emery,¹⁶ Lars Engebretsen,¹⁷ Nina Feddermann-Demont,^{18,19} Christopher C Giza,^{20,21} Kevin M Guskiewicz,²² Stanley Herring,²³ Grant L Iverson,²⁴ Karen M Johnston,²⁵ James Kissick,²⁶ Jeffrey Kutcher,²⁷ John J Leddy,²⁸ David Maddocks,²⁹ Michael Makdissi,^{30,31} Geoff Manley,³² Michael McCrea,³³ William P Meehan,^{34,35} Sinji Nagahiro,³⁶ Jon Patricios,^{37,38} Margot Putukian,³⁹ Kathryn J Schneider,⁴⁰ Allen Sills,^{41,42} Charles H Tator,^{43,44} Michael Turner,⁴⁵ Pieter E Vos⁴⁶

What do we know about concussion regarding return-to-sport?

Table 1 Graduated return-to-sport (RTS) strategy

Stage	Aim	Activity	Goal of each step
1	Symptom-limited activity	Daily activities that do not provoke symptoms	Gradual reintroduction of work/school activities
2	Light aerobic exercise	Walking or stationary cycling at slow to medium pace. No resistance training	Increase heart rate
3	Sport-specific exercise	Running or skating drills. No head impact activities	Add movement
4	Non-contact training drills	Harder training drills, eg, passing drills. May start progressive resistance training	Exercise, coordination and increased thinking
5	Full contact practice	Following medical clearance, participate in normal training activities	Restore confidence and assess functional skills by coaching staff
6	Return to sport	Normal game play	

What do we know about concussion regarding return-to-school?

Table 2 Graduated return-to-school strategy

Stage	Aim	Activity	Goal of each step
1	Daily activities at home that do not give the child symptoms	Typical activities of the child during the day as long as they do not increase symptoms (eg, reading, texting, screen time). Start with 5–15 min at a time and gradually build up	Gradual return to typical activities
2	School activities	Homework, reading or other cognitive activities outside of the classroom	Increase tolerance to cognitive work
3	Return to school part-time	Gradual introduction of schoolwork. May need to start with a partial school day or with increased breaks during the day	Increase academic activities
4	Return to school full time	Gradually progress school activities until a full day can be tolerated	Return to full academic activities and catch up on missed work

- Changes in practice:
 - Dangers of isolation
 - Potential benefits of early (sub-threshold) exercise

What's effective for primary prevention?

Intervention (Rules, Equipment, Training)	Strength of evidence
Prohibiting body checking in youth (<13yo) ice hockey	Consistent protective effect in reducing the risk of SRC
Mandatory helmet use in skiing/snowboarding.	Sufficient evidence for reduction of overall head injury
Mouth guard use	Mixed evidence; trend towards a protective effect in collision sports

What's not effective for primary prevention?

Intervention (Training, Officiating)	Strength of evidence
Limiting contact in youth football practices	Reduces the frequency of head contact, but not in SRC risk
1. Fair play rules in youth ice hockey 2. Tackle training without helmets/ shoulder pads in youth football 3. Tackle technique training in professional rugby	No reduction in SRC risk
Stricter rule enforcement of red cards for high elbows in heading duels in professional soccer	Effect not yet demonstrated

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Implementation of the 2017 Berlin Concussion in Sport Group Consensus Statement in contact and collision sports: a joint position statement from 11 national and international sports organisations

- Current areas of concussion research focus (Injury prevention)
 - Implementation and evaluation of the effectiveness of rule changes
 - Risk factors for concussion (host)
 - Genetic studies—apolipoprotein E, glial cell-derived neurotrophic factor, catechol-O-methyltransferase (host)
 - Energy absorbing artificial turf (environment)
 - Energy absorbing helmet technology (host-protective equipment)
 - The role of tackling technique in reducing concussion risk (energy transfer)

HEADS UP FOOTBALL: SAFETY IN ACTION



Starting as three pilot programs in 2012, Heads Up Football is now used by more than 7,000 youth and high school programs, setting the highest standards in the sport and giving the football community one voice when it comes to safety.

Enroll Today

High School and Middle School

Youth Organizations

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Comprehensive Coach Education and Practice Contact Restriction Guidelines Result in Lower Injury Rates in Youth American Football

Zachary Y. Kerr,* PhD, MPH, Susan Yeargin,[†] PhD, ATC,
Tamara C. Valovich McLeod,[‡] PhD, ATC, FNATA, Vincent C. Nittoli,[§] MS, ATC,
James Mensch,[†] PhD, ATC, Thomas Dodge,^{||} PhD, ATC, Ross Hayden,* MA,
and Thomas P. Dompier,*[¶] PhD, ATC

Investigation performed at Datalys Center for Sports Injury Research and Prevention, Indianapolis, Indiana, USA

Purpose: To compare injury rates among youth football players aged 5 to 15 years by whether their leagues implemented HUF and/or were PW-affiliated.

Study Design: Cohort study; Level of evidence, 2.

Methods: Athletic trainers (ATs) evaluated and tracked injuries at each practice and game during the 2014 youth football season. Players were drawn from 10 leagues across 4 states. The non-Heads Up Football (NHUF) group consisted of 704 players (none of whom were PW-affiliated) from 29 teams within 4 leagues. The HUF+PW group consisted of 741 players from 27 teams within 2 leagues. The HUF-only group consisted of 663 players from 44 teams within 4 leagues. Injury rates and injury rate ratios (IRRs) were reported with 95% CIs.

TABLE 2
Injury Rates in Youth Football Teams, by Implementation of Heads Up Football, Affiliation With Pop Warner Football, and Event Type^a

	HUF+PW		HUF-only		NHUF ^b		Rate Ratio (95% CI)		
	n	Rate ^c	n	Rate ^c	n	Rate ^c	HUF+PW vs NHUF	HUF-only vs NHUF	HUF+PW vs HUF-only
Practice									
All injuries	20	0.97	42	2.73	148	7.32	0.13 (0.08-0.21) ^e	0.37 (0.26-0.53) ^e	0.36 (0.21-0.61) ^e
Time-loss injuries ^d	14	0.68	29	1.89	56	2.77	0.25 (0.14-0.44) ^e	0.68 (0.43-1.07)	0.36 (0.19-0.68) ^e
Concussions	4	0.19	10	0.65	12	0.58	0.33 (0.11-1.02)	1.10 (0.47-2.54)	0.30 (0.09-0.96) ^e
Game									
All injuries	15	3.42	55	13.76	90	13.48	0.25 (0.15-0.44) ^e	1.02 (0.73-1.43)	0.20 (0.12-0.36) ^e
Time-loss injuries ^d	10	2.28	24	6.01	35	5.24	0.43 (0.22-0.88) ^e	1.15 (0.68-1.93)	0.38 (0.18-0.79) ^e
Concussions	3	0.68	6	1.50	10	1.46	0.46 (0.13-1.66)	1.39 (0.60-3.22)	0.37 (0.09-1.50)

^aHUF-only, Heads Up Football/non-Pop Warner-affiliated; HUF+PW, Heads Up Football and Pop Warner-affiliated; NHUF, non-Heads Up Football.

^bPlayers in the non-Heads Up Football group were also not affiliated with Pop Warner Football.

^cRate per 1000 athlete-exposures, defined as 1 athlete's participation in 1 practice or 1 competition.

^dTime-loss injuries are those injuries that restrict participation for at least 24 hours.

^eSignificant differences between groups analyzed.

YOUTH LEAGUES THAT EMPLOYED HEADS UP FOOTBALL SAW ...

63% ↓ **LOWER**
INJURY RATES
IN PRACTICE

PEER-REVIEWED AND PUBLISHED IN THE ORTHOPAEDIC JOURNAL OF SPORTS MEDICINE, JULY 2015

YOUTH LEAGUES THAT EMPLOYED HEADS UP FOOTBALL AND POP WARNERS PRACTICE RESTRICTION GUIDELINES SAW ...

87% ↓ **LOWER**
INJURY RATE
DURING PRACTICE


*USA FOOTBALL COMMISSIONED RESEARCH IS PUBLICIZED ONLY WHEN IT HAS BEEN PEER-REVIEWED AND PUBLISHED.



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Coaches' Implementation of the USA Football "Heads Up Football" Educational Program.

Kerr,ZY , Kroshus,E , et al *Health promotion practice* (volume 19 issue 2 pages 184-193)  March 2018

DOI: 10.1177/1524839917700398 PMID: 28351166 Source: <https://www.ncbi.nlm.nih.gov/...>

ISSN: 1524-8399 EISSN: 1552-6372

An integral part of the Heads Up Football (HUF) educational program is the Player Safety Coach (PSC), who is responsible for teaching other coaches within a youth football league about safer blocking/tackling and injury prevention...

Nearly half of coaches (44.8%) did not attend the PSC clinic; 25.9% reported not seeing their league's PSC on the field on a regular basis. The lack of PSC on-site presence was significantly associated with worse implementation for "concussion recognition and response," "heat preparedness and hydration," and "sudden cardiac event preparedness."

PSC clinic attendance was not associated with implementation. Opportunities exist for improvement in the HUF educational program as there appears to be inconsistent implementation. Further research is warranted to understand how to optimize the role of the PSC in the youth sports context.

Chronic Traumatic Encephalopathy (CTE)

CTE is a neurodegenerative disease that is associated with changes and deficits in cognition, behavior, mood, and motor skills. It is believed to be caused in part by exposure to repetitive head impacts, including concussions as well as subconcussive trauma (i.e., head impacts that do not cause symptoms of concussion).
(CDC Heads Up)

Signs and Symptoms Generally Fall Into Four Groups



COGNITIVE: Problems with memory, executive functioning, and impaired attention.



BEHAVIORAL: Impulsivity, quick temper (“short fuse”), verbal and physical violence, and rage.



MOOD: Depression, hopelessness, anxiety, and apathy.



MOTOR: Parkinsonism, including ataxia, dysarthria, poor gait, tremor, and masked facies.

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Junior Seau (1969-2012)

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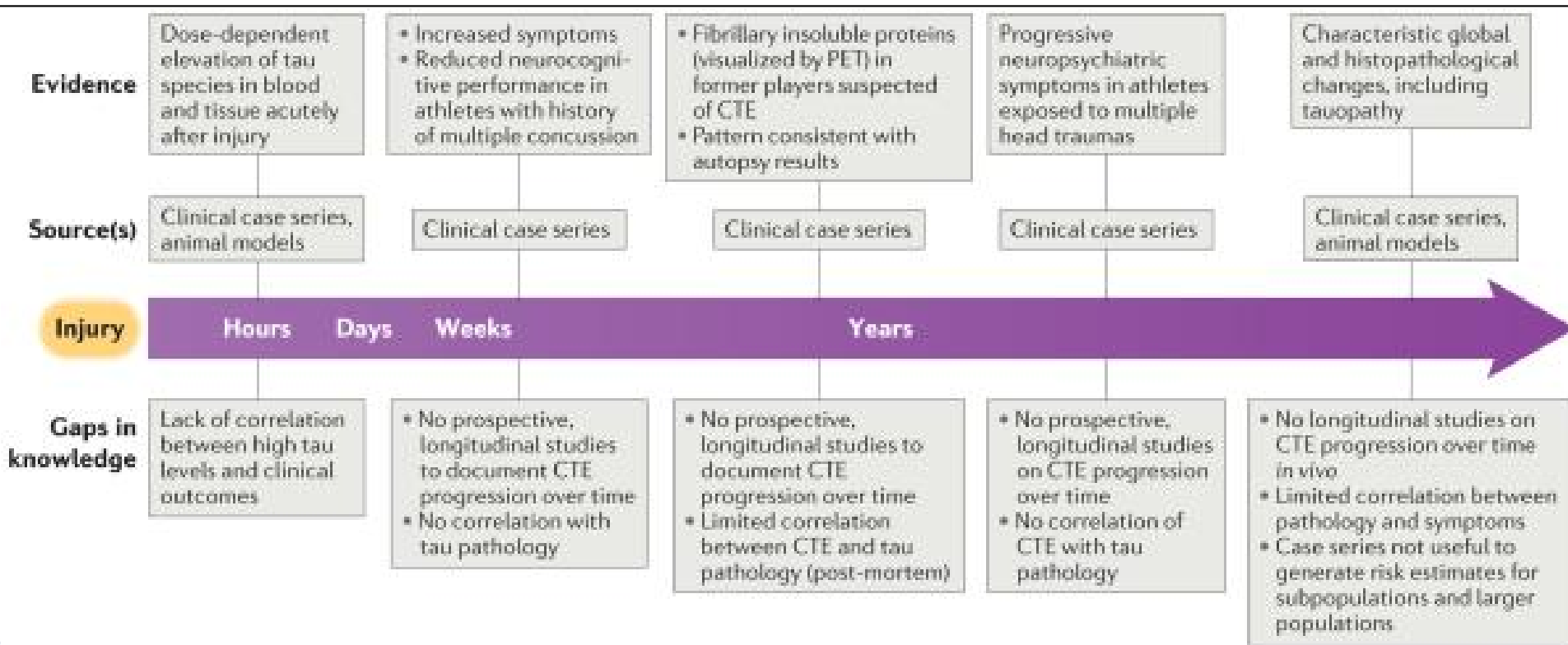
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Sports-related concussions – media, science and policy

Rebekah Mannix , William P. Meehan III & Alvaro Pascual-Leone

Nature Reviews Neurology 12, 486–490 (2016)

Published: 01 July 2016



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From concussion to CTE — sequence of events and knowledge gaps

Data from clinical case series and animal models suggest that athletes who sustain concussions could develop a form of tauopathy, chronic traumatic encephalopathy (CTE), which leads to the deposition of fibrillary insoluble proteins and progressive deterioration of brain function. A definitive causal link between concussion and CTE has yet to be established, however.

Robert Stern: "repetitive head impact exposure is a necessary variable for getting the disease, but it's obviously not sufficient, because not everyone who hits their head is going to get this brain disease. That's pretty much all we know. ... I'm the one person who says over and over again we have no idea what's going on yet. People should not overreact and be fearful that they're going to develop CTE, especially our youth athletes."



On the other hand...

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110

N.F.L. Brains

A neuropathologist has examined the brains of 111 N.F.L. players — and 110 were found to have C.T.E., the degenerative disease linked to repeated blows to the head.

By Joe Ward, Josh Williams and Sam Manchester
July 25, 2017



Editorial

Sports concussion research, chronic traumatic encephalopathy and the media: repairing the disconnect

Andrew W Kuhn,¹ Aaron M Yengo-Kahn,^{1,2} Zachary Y Kerr,³
Scott L Zuckerman^{1,2}

How did an athlete with treatable depression come to believe that he had an untreatable condition and commit suicide?



The Disconnect

- Create a "sensationalized state of fear" about CTE
- Ignore and/or severely criticize research findings that don't fit the football = dementia narrative
- Label anyone who dares to challenge that narrative or call for further study a 'CTE denier' or a 'shill' trying to advance their own vested interests
- Confuse the public and conflate the issues

Prescribed Repair: A three-pronged approach

1. Acknowledge our own biases:
 1. 'belief bias,' causing us to stubbornly adhere to the most intuitively attractive conclusions and own beliefs
 2. 'illusion of validity' bias, which falsely equates research quantity and quality
 3. 'bias blind spot': the tendency to see oneself as less biased than others
2. More education of the media (translational efforts)
3. Promote cordial discourse among researchers

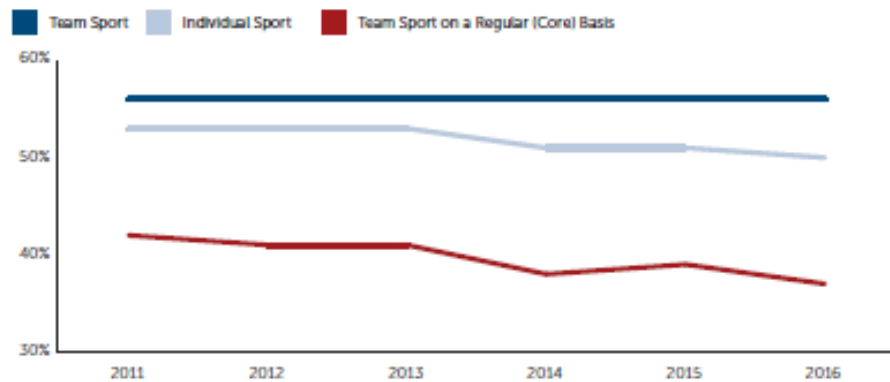
STATE OF PLAY 2017

TRENDS AND DEVELOPMENTS



TOTAL SPORT PARTICIPATION RATES

Percentage of children ages 6 to 12 who played at least one day during the year

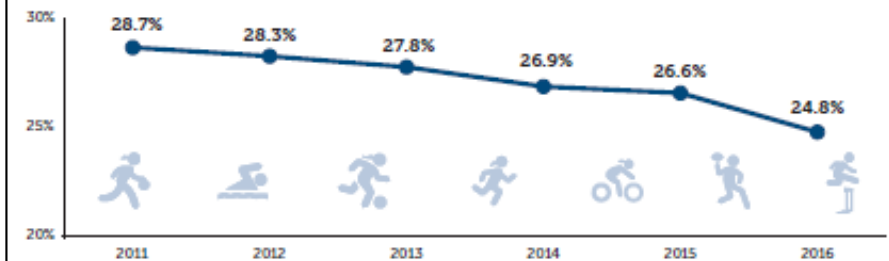


THE STATE OF PLAY IN THE U.S.

SCOREBOARD

ACTIVE TO A HEALTHY LEVEL

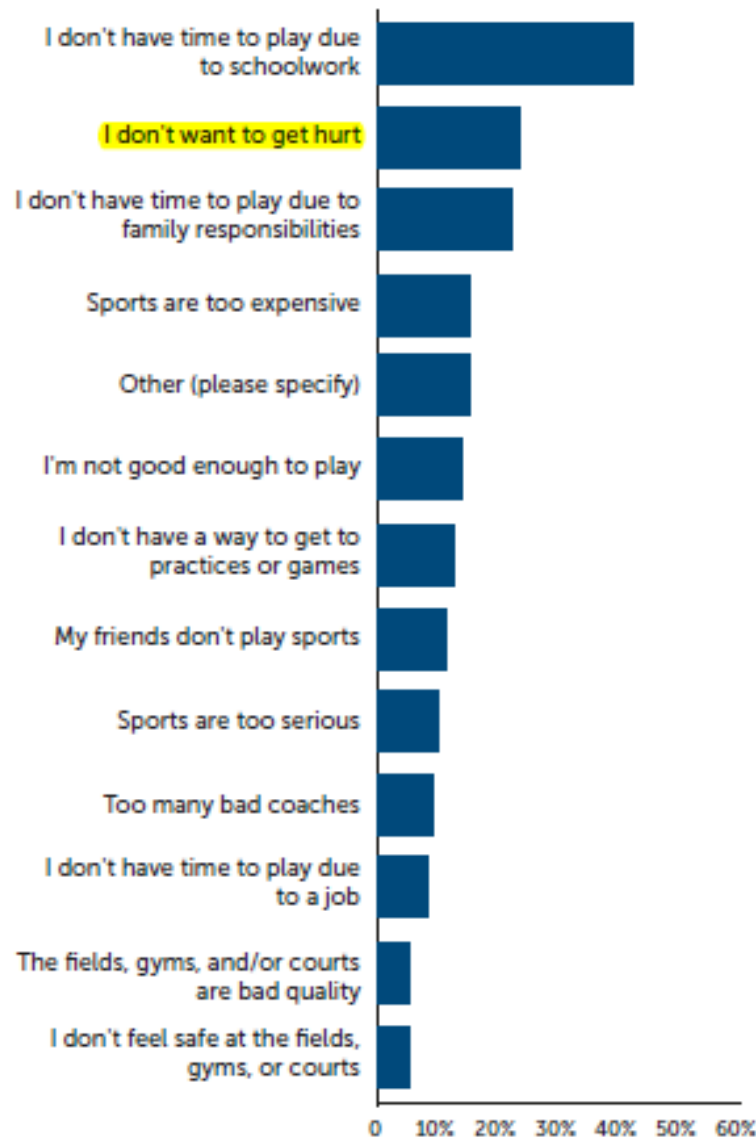
Percentage of kids who regularly participated in high-calorie-burning sports



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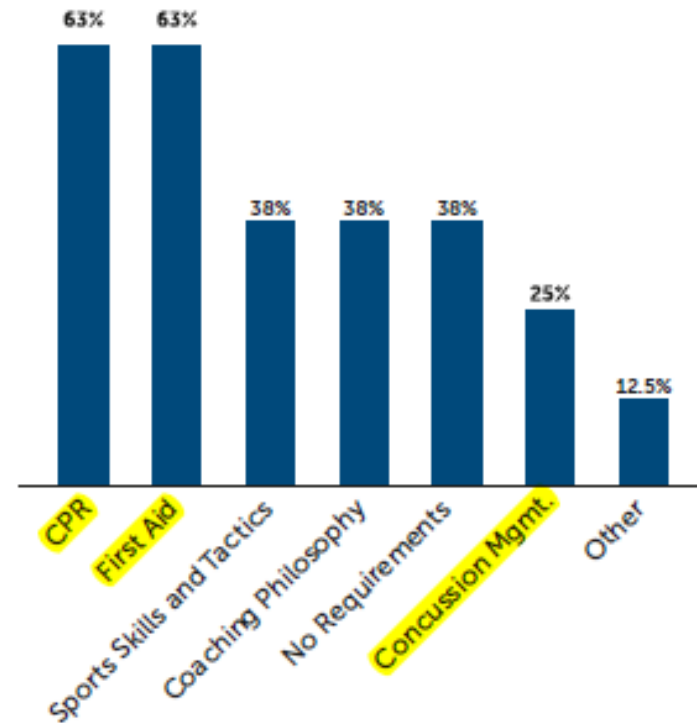
FIG. 3 | WHY KIDS SAY THEY DON'T PLAY



Five findings in East Baltimore:

- Fear of injury is limiting sports participation. A 2017 Harris Poll conducted on behalf of the American Osteopathic Association found that 16 percent of parents are now concerned enough about concussion risks that they won't let their child play any sport. Our survey of youth in East Baltimore found that they

FIG. 8 | TRAINING REQUIREMENTS OF COACHES BY SCHOOLS



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New York Legislator Renews Effort to Bar Tackle Football for Children



Ken Belson, NY Times,
Jan 24, 2018

- NY Assemblyman Michael Benedetto: “There are laws that you need to use a car seat, wear a bicycle helmet. It’s the same principle.”
- Dr. Robert Cantu: “... health experts set age minimums for all sorts of activities like drinking, smoking and driving, and the science is never purely black and white.”

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Rule Changes by Youth Sports NGBs

- Promotion of flag football as a safer alternative to tackle;
 - Participation rates have risen sharply.
- United States Soccer Federation rule changes:
 - In 2015, banned players age 10 and younger from heading the ball
 - Will reduce headers in practice for those from ages 11-13.
- Pop Warner (youth football) rule changes:
 - In 2016, the organization eliminated kickoffs in its three youngest divisions (5-10 years old).
 - Reduced the amount of contact time in practice in all age groups, to 25 percent.

Youth Football Injuries

A Prospective Cohort

Andrew R. Peterson,^{*†} MD, MSPH, Adam J. Kruse,[†] MS, Scott M. Meester,[†] BS,
Tyler S. Olson,[†] BS, Benjamin N. Riedle,[†] MS, Tyler G. Slayman,[‡] MD, Todd J. Domeyer,[§] MD,
Joseph E. Cavanaugh,[†] PhD, and M. Kyle Smoot,^{||} MD

Investigation performed at University of Iowa, Iowa City, Iowa, USA

TABLE 2
Comparison of Injury Rates Between League Types

League Type	Response Variable	Ratio Estimate	95% CI	P Value
Flag vs tackle	Injury rate	2.217	1.249, 3.934	.0065
Flag vs tackle	Severe injury rate	0.9489	0.2979, 3.0229	.9293
Flag vs tackle	Concussion rate	1.961	0.5985, 6.4257	.2660

What's on the horizon...

Consensus statement

Implementation of the 2017 Berlin Concussion in Sport Group Consensus Statement in contact and collision sports: a joint position statement from 11 national and international sports organisations

The 2017 Berlin Concussion in Sport Group Consensus Statement provides a global summary of best practice in concussion prevention, diagnosis and management, underpinned by systematic reviews and expert consensus.

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Comparing Health-Related Policies & Practices in Sports: The NFL and Other Professional Leagues



THE FOOTBALL PLAYERS
HEALTH STUDY
AT HARVARD UNIVERSITY

Christopher R. Deubert
I. Glenn Cohen
Holly Fernandez Lynch

Petrie-Fiom Center for Health Law
Policy, Biotechnology, and Bioethics
Harvard Law School

May 2017

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PINK CONCUSSIONS



SESSION SPOTLIGHT

PINK CONCUSSIONS PANEL: THE FACES OF FEMALE BRAIN INJURY



Katherine Snedaker, LCSW

Executive Director
PINK Concussions

Wednesday June 13
7:30 AM - 8:45 AM

4th Federal Interagency Conference
on Traumatic Brain Injury

WASHINGTON, DC
JUNE 11 - 13, 2018

June 5, 20

Knowledg

THE NCAA-DOD GRAND ALLIANCE: A UNIQUE COLLABORATION

Brian Hainline, MD

NCAA Chief Medical Officer

Clinical Professor of Neurology

Indiana University School of Medicine

New York University School of Medicine



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CONCUSSION GAP ANALYSIS

▶ What is the natural history of concussion?

- ▶ Short-term and long-term.
- ▶ What functional domains are reliably impaired?
- ▶ Are specific functional domains more or less predictive of recovery trajectory?

▶ Are all sports-related concussions the same?

- ▶ Most work has been in men.
- ▶ Most studies in American football.

▶ What is the neurobiology of concussion?

- ▶ Are there critical biomechanical elements that predict concussion, prognosis, and recovery?
- ▶ Is concussion the right metric? What about repetitive head impact exposure?
- ▶ Is there disconnect between clinical and neurophysiological “return to play” point?
- ▶ Do these issues differ across sex and sport?

▶ What role can neuroimaging biomarkers, fluid biomarkers, and genotype play in answering these questions?

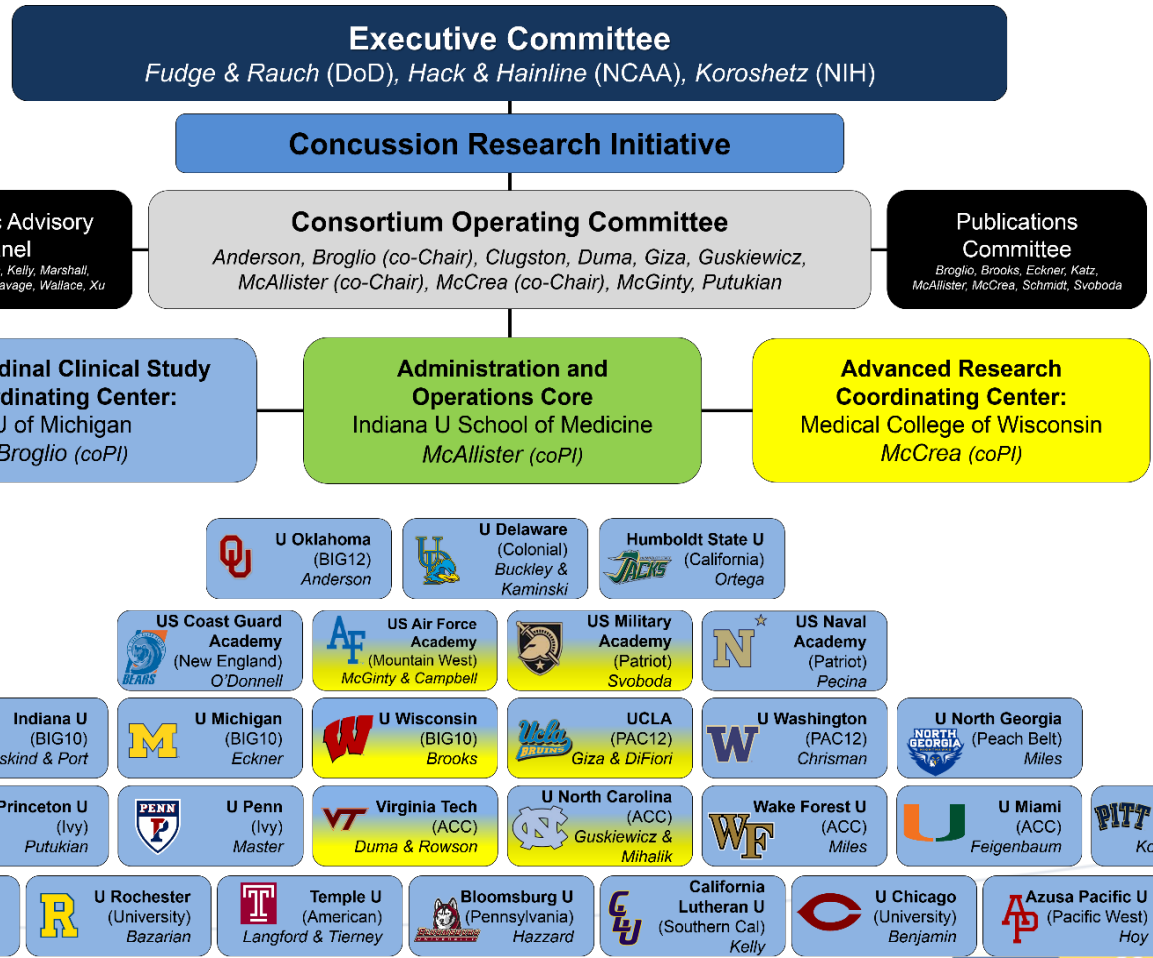
FURTHER GAP ANALYSIS

- ▶ **Does knowledge of concussion lead to behavioral safety changes?**
- ▶ **What are the perceived norms of concussion safety?**
- ▶ **What is the evidence that perceived norms and the culture of concussion safety can be shifter through intervention?**

NCAA-DoD CARE Consortium:

Sponsored by U.S. Dept. of Defense (DoD) & NCAA

Principal Investigators: S. Broglio, PhD, Thomas McAllister, MD, Michael McCrea, PhD



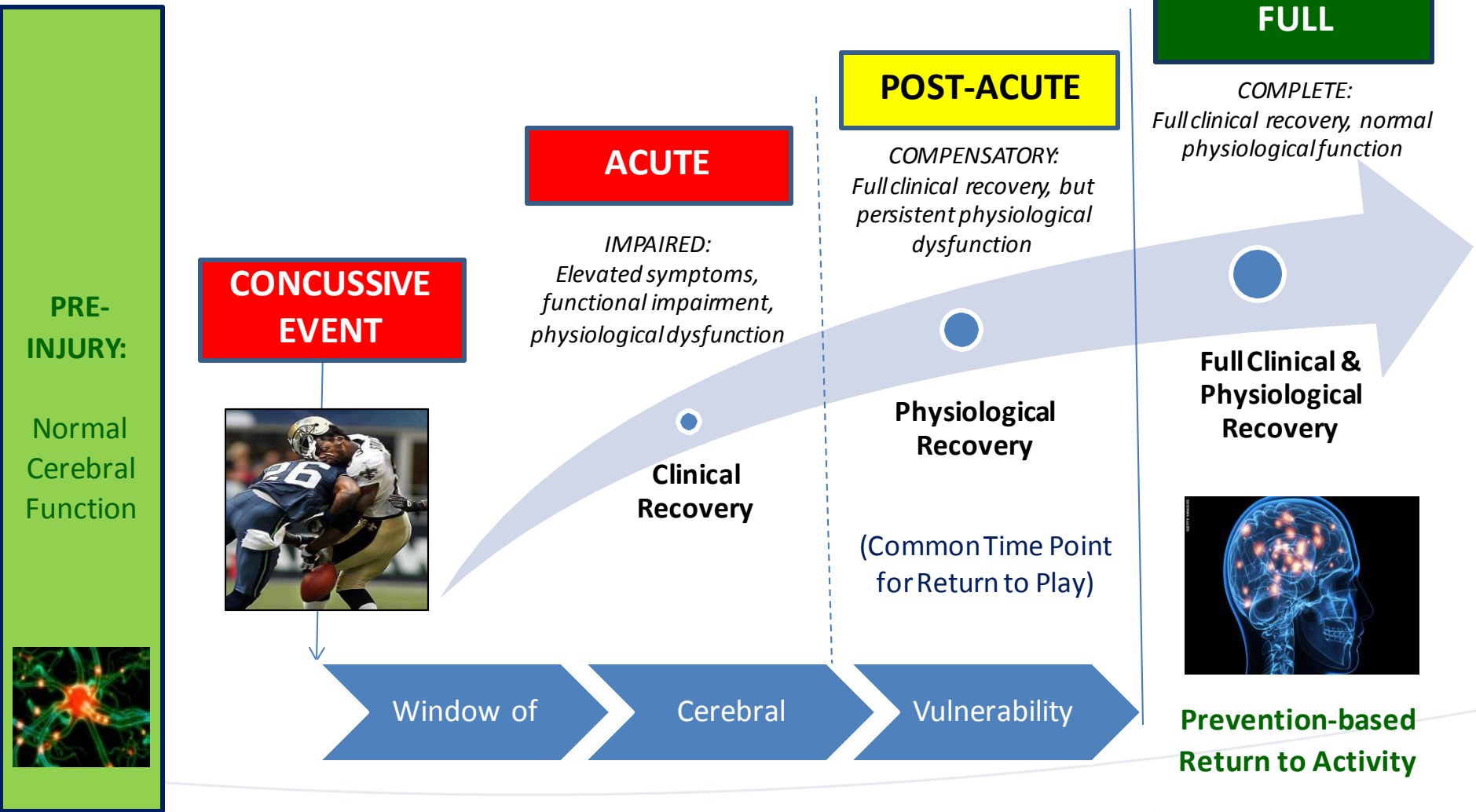
Aims of the CARE Consortium

To conduct the largest, most comprehensive study of the natural history of concussion in **NCAA Student Athletes** And **Military Service Academy Cadets**

- **AIM 1**: *Create a national multi-site consortium for concussion research*
- **AIM 2**: *Conduct a prospective, longitudinal, multi-site, multi-sport study of the natural history of concussion in males and females*
- **AIM 3**: *Conduct advanced studies that integrate biomechanical, clinical, neuroimaging, neurobiological and genetic markers of injury to advance our understanding of neurobiology of concussion*



Integrated Recovery Model



Science Informing Clinical Management

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Future Directions: Multi-Dimensional Model of Recovery & Outcome



**Understanding How Individual Factors Predict Recovery,
Outcome and Risk after SRC**

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Conclusions

- Challenging areas for research
- Need for big data & collaboration
- Longitudinal studies
- Evaluations of primary prevention interventions
- Coordination across populations (age, sport, sex, level of play)
- Science-media collaboration

Thank you!

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