DEFENSE CENTERS OF EXCELLENCE

For Psychological Health & Traumatic Brain Injury

Concussion and Winter Sports

February 11, 2016, 1-2:30p.m. ET

Presenters

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Moderator

Scott Livingston, Ph.D., PT, ATC, SCS
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DVBIC Defense and Veterans Brain Injury Center

DHCC

National Center for Telehealth & Technology

Webinar Details

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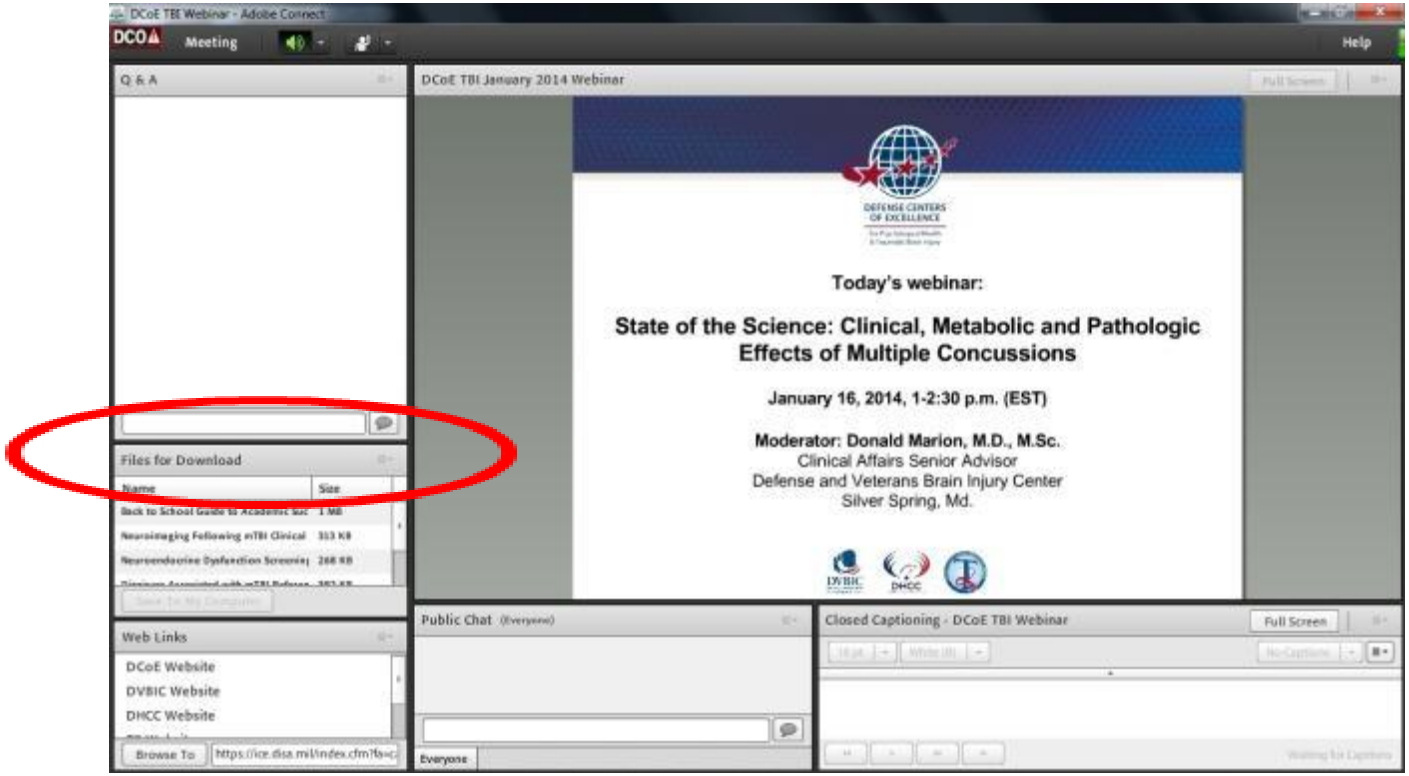

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Summary and Learning Objectives

Nearly four million Americans are affected by sport or recreational traumatic brain injuries annually. Winter sports (e.g., ice hockey, skiing, sledding) are often fast-paced, high-velocity activities that can lead to serious injury including concussion, or mild traumatic brain injury. Surprisingly, head injuries in winter sports have not been studied as frequently as those in football or soccer. The most studied winter sport is ice hockey. This webinar will provide an overview of winter sports injury with an emphasis on ice hockey research designed to understand injury mechanisms, dispel concussion myths, and present novel opportunities for preventing injury.

At the conclusion of this webinar, participants will be able to:

- Discuss the epidemiology of winter sports concussion with a primary emphasis on ice hockey
- Articulate the effectiveness of prevention interventions including education, protective gear, and rule changes in organized sports
- Employ educational resources to reduce the risk, incidence, severity and consequences of concussion in ice hockey

Jason P. Mihalik, Ph.D., CAT(C), ATC

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- Assistant professor in the Department of Exercise and Sport Science and co-director of the Matthew A. Gfeller Sport-Related Traumatic Brain Injury Research Center at The University of North Carolina at Chapel Hill
- Research interests include:
  - Biomechanics of head trauma
  - Common pathways to managing head trauma from the sideline through the emergency department
  - Potential for concussion rehabilitation in virtual reality environments
- Education:
  - Ph.D., Interdisciplinary Curriculum in Human Movement Science, The University of North Carolina at Chapel Hill
  - M.S., Sports Medicine, University of Pittsburgh

Erin B. Wasserman, Ph.D.

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- Postdoctoral research fellow in the Department of Exercise and Sport Science at The University of North Carolina at Chapel Hill
- Research interests include:
  - Prevention and management of concussion
  - Identification of demographic, clinical and biomechanical risk factors of concussion and poor outcome following injury
- Education:
  - Ph.D., Epidemiology, University of Rochester School of Medicine and Dentistry

Concussion and Winter Sports

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play it safe

Matthew Gfeller

Sport-Related TBI Research Center

The University of North Carolina at Chapel Hill

THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL

Disclosures – Dr. Mihalik

- The views expressed herein are those of the presenter and do not reflect the official policy of the Department of the Army, Department of Defense, or DVBIC.
- The presenter does not intend to discuss the off-label/investigative (unapproved) use of commercial products or devices.
- The presenter is the chief science officer for Senaptec LLC and is the co-author of the Concussion Recognition and Response App.

Disclosures – Dr. Wasserman

- The views expressed herein are those of the presenter and do not reflect the official policy of the Department of Defense or DVBIC.
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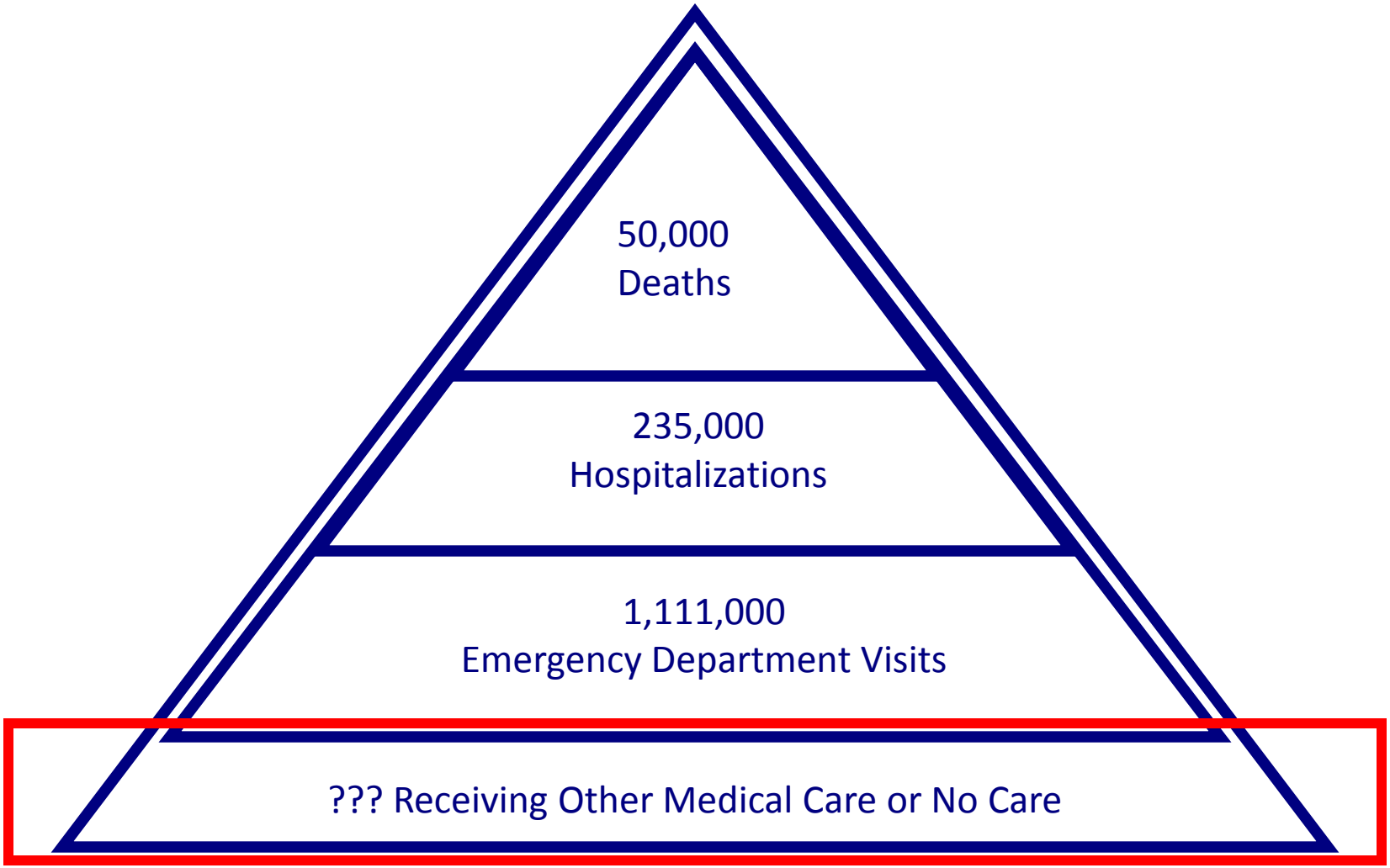
Brain injury: a major public health concern



(Langlois, Rutland-Brown, & Thomas, 2004)

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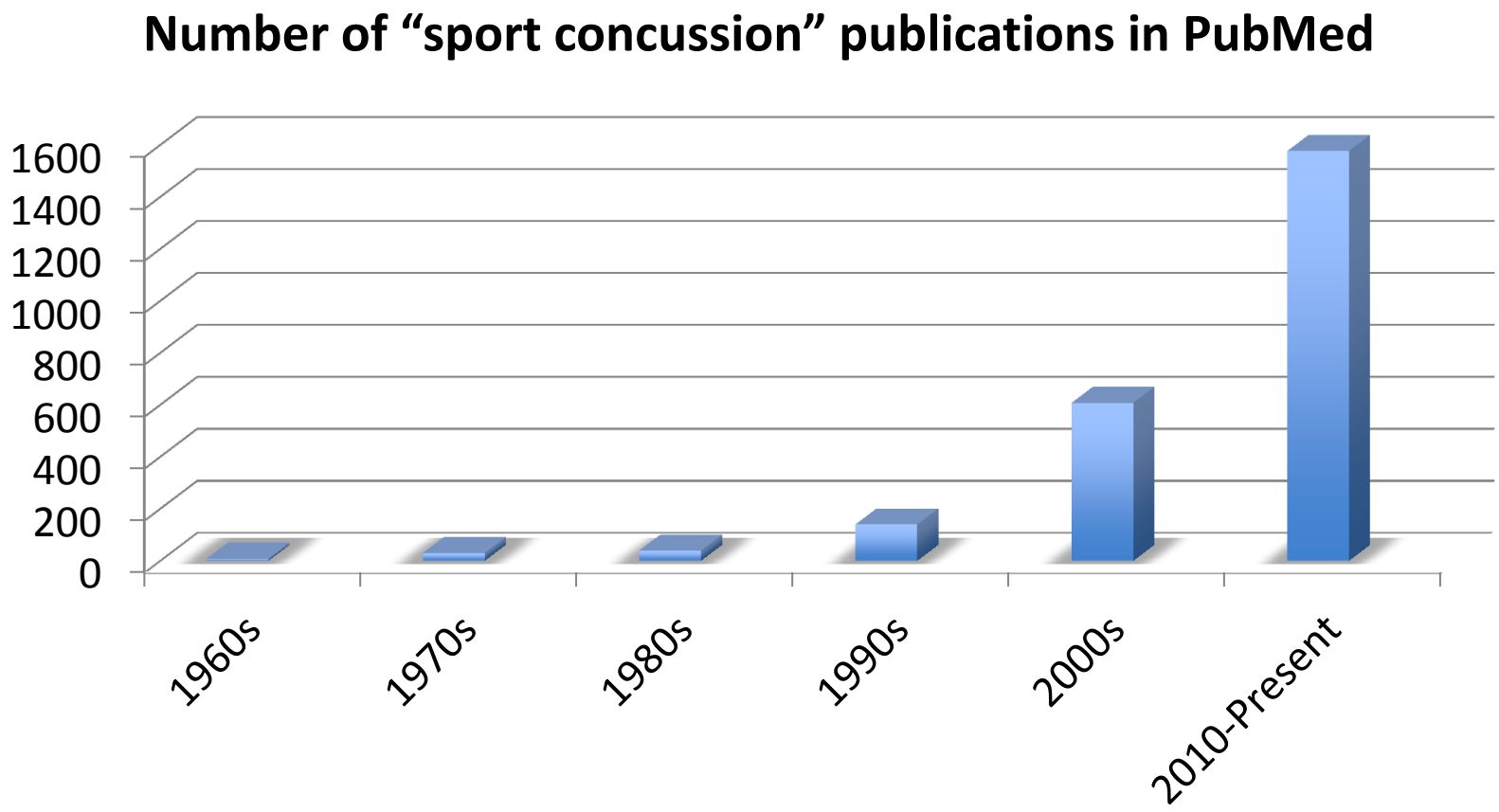
Sport concussion evidence



PubMed search string "sport concussion" on 02/04/16

TBI: A multifaceted condition

Winter Sports Head Injuries

Sport	Incidence
Alpine Skiing	3.5 per 100 athletes per season (Steenstrup, Bere, & Bahr, 2014)
Downhill Skiing	0.77 – 3.8 / 100,000 Visits (Fukuda, Takaba, Saito, & Endo, 2001; Diamond, Gale, & Denkhaus, 2001)
Freestyle Skiing	5.7 per 100 athletes per season (Steenstrup, Bere, & Bahr, 2014)
Snowboarding	Amateur: 6.5/ 100,000 visits (Nakaguchi, Fujimaki, Ueki, Takahashi, Yoshida, & Kirino, 1999) Professional: 5.0 per 100 athletes per season (Steenstrup, Bere, & Bahr, 2014)
Snowmobiling	13-34% of all injuries are head injuries (Chaze & McDonald, 2008)
Sledding	13% of all sledding injuries are head injuries (Chaze & McDonald, 2008)
Luge	5.2% of all luge injuries are head injuries (Cummings, Shurland, Prodoehl, Moody, & Sherk, 1997) 2.5% of all luge injuries were concussions (Cummings, Shurland, Prodoehl, Moody, & Sherk, 1997)
Ice Skating	13.3% of ice skating injuries (under age 18) (Knox, Comstock, McGeehan, & Smith, 2006)
Sochi Winter Olympics	11 concussions among 2,780 athletes (0.4%) 2.8% of all injuries (Soligard et al., 2015)

Concussion in Ice Hockey

Level	Incidence	Proportion of all injuries
Youth		
Male		
Ages 11-12	0.4-1.5 per 1,000 player-hours (Emery et al., 2010)	28-35% (Emery et al., 2010)
Ages 13-14	0.8-0.9 per 1,000 player-hours (Emery et al., 2010)	10% (Emery, Kang, Schneider, & Meeuwisse, 2011)
Female		
Ages 9-17	0.3 per 1,000 player-hours (Decloe, Meeuwisse, Hagel & Emery, 2014)	15.1% (Decloe, Meeuwisse, Hagel, & Emery, 2014)
High School		
Male	5.4 per 10,000 athletic exposures (AEs) (Marar, McIlvain, Fields, & Comstock, 2012)	No Data Available
Female	No Data Available	No Data Available
College		
Male	7.91 per 10,000 AEs (Zuckerman et al., 2015)	8% (Agel, Dick, Nelson, Marshall, & Dompier, 2007)
Female	7.50 per 10,000 AEs (Zuckerman et al., 2015)	18% (Agel, Dick, Nelson, Marshall, & Dompier, 2007)
NHL	1.8 per 1,000 player-hours (Benson, Meeuwisse, Rizos, Kang, & Burke, 2011) 14.5 per 10,000 AEs (Wennberg & Tator, 2008)	No Data Available

Factors Associated with Concussion in Ice Hockey

- Youth
  - Tournaments vs. Games/Practices (Roberts, Brust, & Leonard, 1999)
  - Concussion rates lower in non-checking Pee Wee leagues (Emery et al., 2010)
  - BUT rates lower in Bantam leagues in which players had Pee Wee checking experience (Emery, Kang, Schneider, & Meeuwisse, 2011)
- High School Boys (Marar, McIlvain, Fields, & Comstock, 2012)
  - Mechanism
    - Player-player contact (45 %)
    - Player-boards/glass contact (29%)
    - Player-ice contact (20%)
  - Activity
    - Being checked (30%)
    - Skating (30%)
    - Chasing loose puck (16%)

Factors Associated with Concussion in Ice Hockey

- College
  - Men
    - Player contact while checking (24%)
    - Player contact during general play (23%)
    - Player contact while handling puck (9%)
  - Women
    - Player contact during general play (25%)
    - Surface contact during general play (11%)
    - Player contact while defending (8%)

(Zuckerman et al., 2015)

Concussion Outcomes in Ice Hockey

- High school (Marar, McIlvain, Fields, & Comstock, 2012)
  - Approx. 55% had symptom resolution with 3 days
  - Nearly 50% returned to play in less than 10 days
- College (Wasserman, Kerr, Zuckerman, & Covassin, 2016)
  - Men
    - Approx. 25% had symptom resolution within 3 days
    - Approx. 25% returned to play in less than 7 days
  - Women
    - Approx. 25% had symptom resolution within 3 days
    - Approx. 35% returned to play in less than 7 days

Prevention as treatment

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Head Impact Monitoring Systems

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Using impact biomechanics to prevent TBI in youth ice hockey

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Characteristics of head impacts sustained by youth ice hockey players

J P Mihalik[1,2], K M Guskiewicz[1,2,3*], J A Jeffries[1], R M Greenwald[4,5], and S W Marshall[3,6]
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The manuscript was received on 2 October 2007 and was accepted after revision for publication on 19 February 2008.

DOI: 10.1243/17543371JSET4

Abstract: This study aimed to measure the magnitude of head impacts sustained by 14 male, youth (13 years old) ice hockey players wearing instrumented helmets, and to compare impacts across event type (practice, game), player position, and location. Head impact magnitudes were captured during 58 games and 51 practices. Mixed linear models were utilized to analyze differences by event type, player position, and location of impact. Game impact magnitudes were significantly greater than practice impacts. Impacts sustained by forwards were similar in magnitude to those sustained by defensemen. Significant differences between head impact locations across all player positions were observed. Impacts to the top of the head were significantly greater than impacts to the back, front, left, and right sides. Youth ice hockey players sustain helmet impacts nearing 20 *g* on average, similar to measured values in collegiate American football players, and of potential concern because this sample involves younger athletes. Future biomechanical studies are needed to better interpret the finding that there is an increased likelihood of higher magnitude head impacts to the top of the head. The authors' long-term goal is to improve the understanding of impacts that may lead to concussions in young athletes.

(Mihalik , Guskiewicz, Jeffries, Greenwald, & Marshall, 2008)

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Effect of Infraction Type on Head Impact Severity in Youth Ice Hockey

JASON P. MIHALIK[1,2], RICHARD M. GREENWALD[3,4], J. TROY BLACKBURN[2,5], ROBERT C. CANTU[6], STEPHEN W. MARSHALL[7,8], and KEVIN M. GUSKIEWICZ[1,2,8]

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ABSTRACT

MIHALIK, J. P., R. M. GREENWALD, J. T. BLACKBURN, R. C. CANTU, S. W. MARSHALL, and K. M. GUSKIEWICZ. Effect of Infraction Type on Head Impact Severity in Youth Ice Hockey. *Med. Sci. Sports Exerc.*, Vol. 42, No. 8, pp. 1431–1438, 2010. **Purpose**: To identify the effects of infractions sustained during participation in youth ice hockey on biomechanical measures of head impact severity. **Methods**: Sixteen adolescent Bantam-aged male ice hockey players (age = 14.0 ± 0.5 yr, height = 171.3 ± 4.5 cm, mass = 63.7 ± 6.6 kg) were equipped with accelerometer-instrumented helmets to collect biomechanical measures relating to head impacts (linear acceleration, rotational acceleration, and Head Impact Technology severity profile (HITsp)) sustained while participating in ice hockey. Single-camera video footage from 54 games was synchronized with the head impact data, and all viewable collisions (n = 665) were evaluated as resulting from a legal collision or an infraction. Infractions were further categorized into boarding or charging, checking from behind, and elbowing or intentional head contact. Statistical analyses included random-intercepts general linear mixed models. **Results**: Infractions were observed in 17.3% (115/665) of all body collisions. Overall, collisions involving infractions had higher linear accelerations (P = 0.012) and HITsp (P = 0.021) than collisions with no infraction. Specifically, elbowing, head contact, and high sticking infractions resulted in greater linear acceleration (P = 0.005) and HITsp (P = 0.010) than collisions with no infraction. A strong trend for higher rotational accelerations in this infraction type compared with legal collisions was also present (P = 0.059). **Conclusions**: Infractions result in higher measures of head impact severity than noninfraction collisions. Athletes and coaches should conform to playing rules, and officials should enforce more stringently existing rules and assess more severe penalties to participants who purposefully attempt to foul an opponent at the youth ice hockey level. **Key Words:** ADOLESCENT ATHLETE, BIOMECHANICS, CONCUSSION, HELMETS, TRAUMATIC BRAIN INJURY

(Mihalik et al., 2010)

Injury prevention: Anticipation

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Injury prevention: Anticipation

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Collision Type and Player Anticipation Affect Head Impact Severity Among Youth Ice Hockey Players

WHAT'S KNOWN ON THIS SUBJECT: Young hockey players sustain head impacts as severe as those observed for collegiate football players. Increasingly severe head impacts are likely to cause head injuries in athletics.

WHAT THIS STUDY ADDS: This study adds to the body of evidence by addressing the potential importance of collision anticipation in mitigating the severity of head impacts sustained by youth hockey players.

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KEY WORDS

child, concussion, injury, physical activity, sports, trauma

ABBREVIATIONS

CHECC—Carolina Hockey Evaluation of Children's Checking
TBI—traumatic brain injury
HIT—Head Impact Telemetry
HITsp—Head Impact Telemetry severity profile
CI—confidence interval

www.pediatrics.org/cgi/doi/10.1542/peds.2009-2849

doi:10.1542/peds.2009-2849

abstract

OBJECTIVE: The objective was to determine how body collision type and player anticipation affected the severity of head impacts sustained by young athletes. For anticipated collisions, we sought to evaluate different body position descriptors during delivery and receipt of body collisions and their effects on head impact severity. We hypothesized that head impact biomechanical features would be more severe in unanticipated collisions and open-ice collisions, compared with anticipated collisions and collisions along the playing boards, respectively.

(Mihalik et al., 2010)

Visual Function

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- Athletes must be able to accurately:
  - Identify static and dynamic features
  - Scan and interpret visual information
  - Alternate looking between varying distances
  - Perform efficient eye movements
  - Respond quickly to visual stimuli

Sensory Station

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A comparison of various clinical measures of visual performance in healthy participants: A sports concussion perspective

Breton M. E. Asken[1]; Jason P. Mihalik[1,2,3]; Julianne D. Schmidt[1,3]; Ashley C. Littleton[1,3]; Kevin M. Guskiewicz[1,2,3]; Joseph B. Hopfinger[4]

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(Asken et al., in press)

Annals of Biomedical Engineering (© 2013)
DOI: 10.1007/s10439-013-0881-8

The Effect of Visual and Sensory Performance on Head Impact Biomechanics in College Football Players

JACQUELINE A. HARPHAM,[1] JASON P. MIHALIK,[1,2,3] ASHLEY C. LITTLETON,[1] BARNETT S. FRANK,[1] and KEVIN M. GUSKIEWICZ[1,2]

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(Received 30 April 2013; accepted 24 July 2013)

Associate Editor Stefan M. Duma oversaw the review of this article.

Abstract—The development of prevention strategies is critical to address the rising prevalence of sport-related concussions. Visual and sensory performance may influence an individual's ability to interpret environmental cues, anticipate opponents' actions, and create appropriate motor responses limiting the severity of an impending head impact. The purpose of this study was to determine the relationship between traditional and visual sensory reaction time measures, and the association between visual and sensory performance and head impact severity in college football players. Thirty-eight collegiate football players participated in the study. We used real-time data collection instrumentation to record head impact biomechanics during games and practices. Our findings reveal no significant correlations between reaction time on traditional and visual sensory measures. We found a significant association between head

INTRODUCTION

Concussion has been defined as a complex pathophysiologic process affecting the brain, induced by traumatic biomechanical forces that typically result in an impairment of neurologic function and clinical symptoms such as disturbances of vision and equilibrium.[18] Sport-related concussions have become a major public health concern, with approximately 3.8 million sports-related traumatic brain injuries occurring in the United States each year.[16] The majority of sport-related concussions occur in contact or collision sports such as football, which is one of the most popular sports among high school and collegiate

(Harpham, Mihalik, Littleton, Frank, & Guskiewicz, 2013)

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Under 14 Boys vs. Under 14 Boys

- Pre → Permitted Peewee bodychecking
- Post → Not permitted Peewee bodychecking

Era	Mean	95% CI	Median	95th %ile
Pre	21.7 g	21.5 – 21.9	17.3 g	46.7 g
Post	23.9 g	23.3 – 24.4	19.6 g	51.6 g

Speaker research

Boys vs. Girls

- Boys → Permitted to bodycheck
- Girls → Not permitted to bodycheck

Era	Mean	95% CI	Median	95th %ile
Boys	21.7 g	21.6 – 21.9	17.5 g	46.8 g
Girls	22.0 g	20.9 – 23.0	18.3 g	44.4 g

Speaker research

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Source: Google Images

Safer Football, Taught From Inside the Helmet

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Left: UNC athletic trainer Scott Trulock and Dr. Kevin Guskiewicz talking with Offensive Linemen Alan Pelc.
Right: Gfeller Center Doctoral Student Kody Campbell providing mentoring for a high school athlete
By ALAN SCHWARZ **Published: November 5, 2010** ***New York Times***

CHAPEL HILL, N.C. — Alan Pelc has been taught how to block since his Houston boyhood, how to push and pulverize and punish oncoming defenders on the football field. This was different. He was learning how not to punish himself.

"Right there," Dr. Kevin Guskiewicz said, pointing at a presentation screen showing more than a dozen arrows pointed straight into the top of a mannequin head. "These are all your recorded hits to the top of your helmet against L.S.U. Every time you drop your head. These are the ones we're concerned about."

Research Grant 1R49CE002479-01 (CDC/NCIPC ICRC)

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Imaging the Brain for Chronic Effects

- Diffusion Tensor Imaging (DTI)

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Plasma/Serum Biomarkers

Table 1. Blood Biomarkers To Be Studied		
Blood Biomarker	**Short Name**	**Marker for:**
S100 calcium binding protein B	S100B	Blood-brain barrier permeability; CNS injury
Apolipoprotein A	ApoA	Negative marker of inflammation
Apolipoprotein E	ApoE	Marker for traumatic brain injury
Ubiquitin carboxy-terminal hydrolase L1	UCHL1	Neuropathology indicator; Protein turnover
Thyroid stimulating hormone	TSH	Test of thyroid function
Interleukin-6	IL-6	Inflammation; stimulates immune response
High-sensitivity C-reactive protein	hsCRP	General systemic inflammation
High-density lipoprotein	HDL	Cardiovascular health

Sensory Station

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Blast Exposures on All Occupants

Using Blast Gauge readings from operator in back and information about crew locations recreation can approximate exposures on other occupants.

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Only Subject 1 and subject in passenger seat exposed to >16 psi

Passenger foot was outside of vehicle and exposed to blast pressures >500psi
Driver and gunner had low exposures

Source: Dr. Jeffrey Rogers, DARPA

More on Blast Exposures

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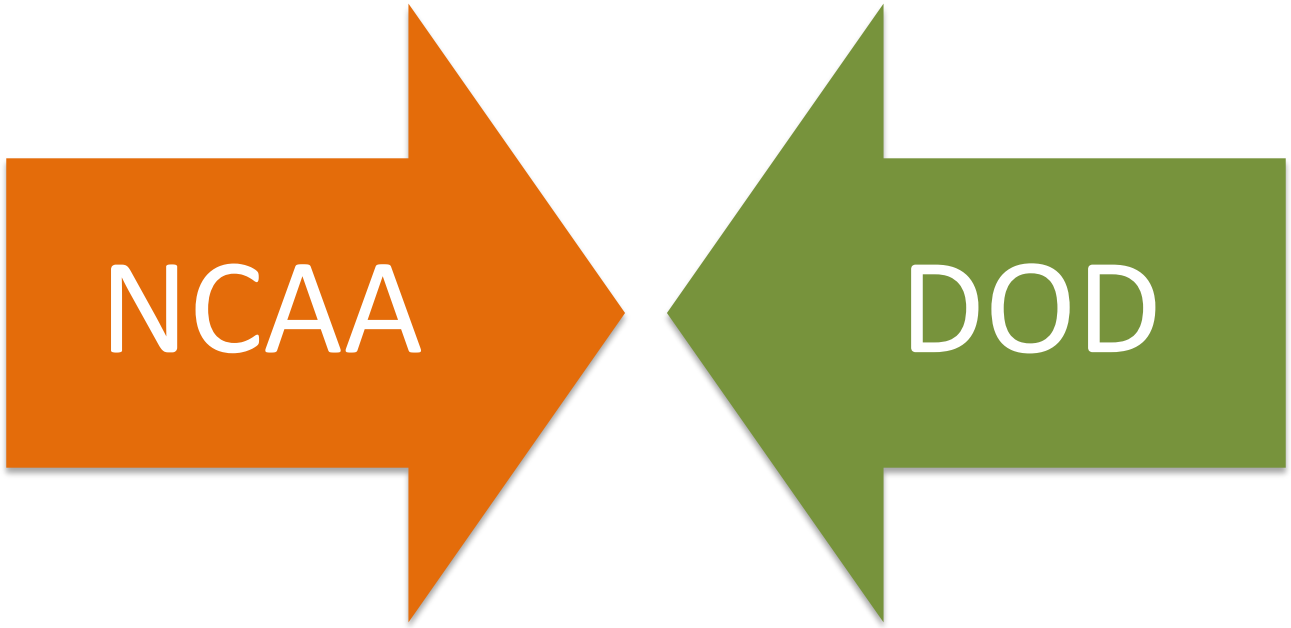
Subject on back left rail of vehicle
exposure was <16 psi (no red)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