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Disclosure of Commercial Support

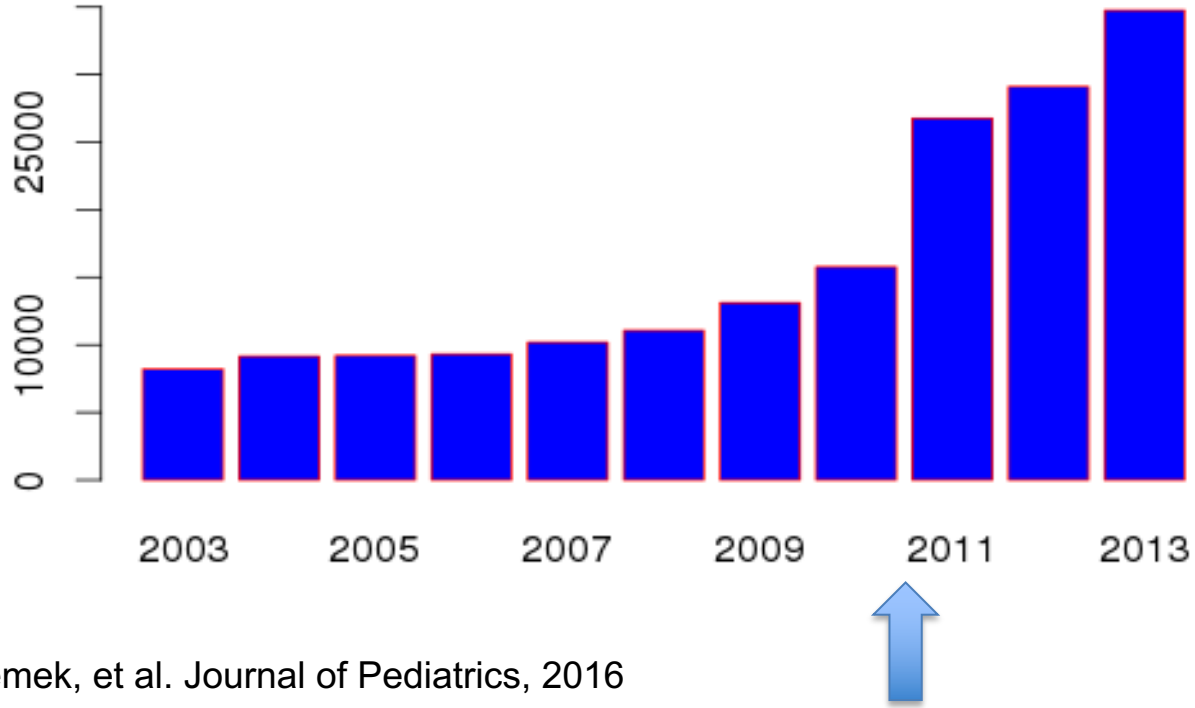
- My program of research has received financial support through competitively-funded research grants from CIHR, Ontario Neurotrauma Foundation (ONF), Physician Services Incorporated (PSI) Foundation, CHEO Foundation, Ontario Brain Institute (OBI), National Football League (NFL), Parachute Canada and Ontario SPOR Support Unit (OSSU).

- I am supported by a Tier 1 Clinical Research Chair in Pediatric Concussion from University of Ottawa

- Potential for conflict of interest: Co-Founder and Scientific Director of 360 Concussion Care

The Concussion Epidemic

- CDC calls concussion a “Silent epidemic”
- Collaboration with ICES Data Discovery Better Health
- ED and office visits in Ontario 2003-13



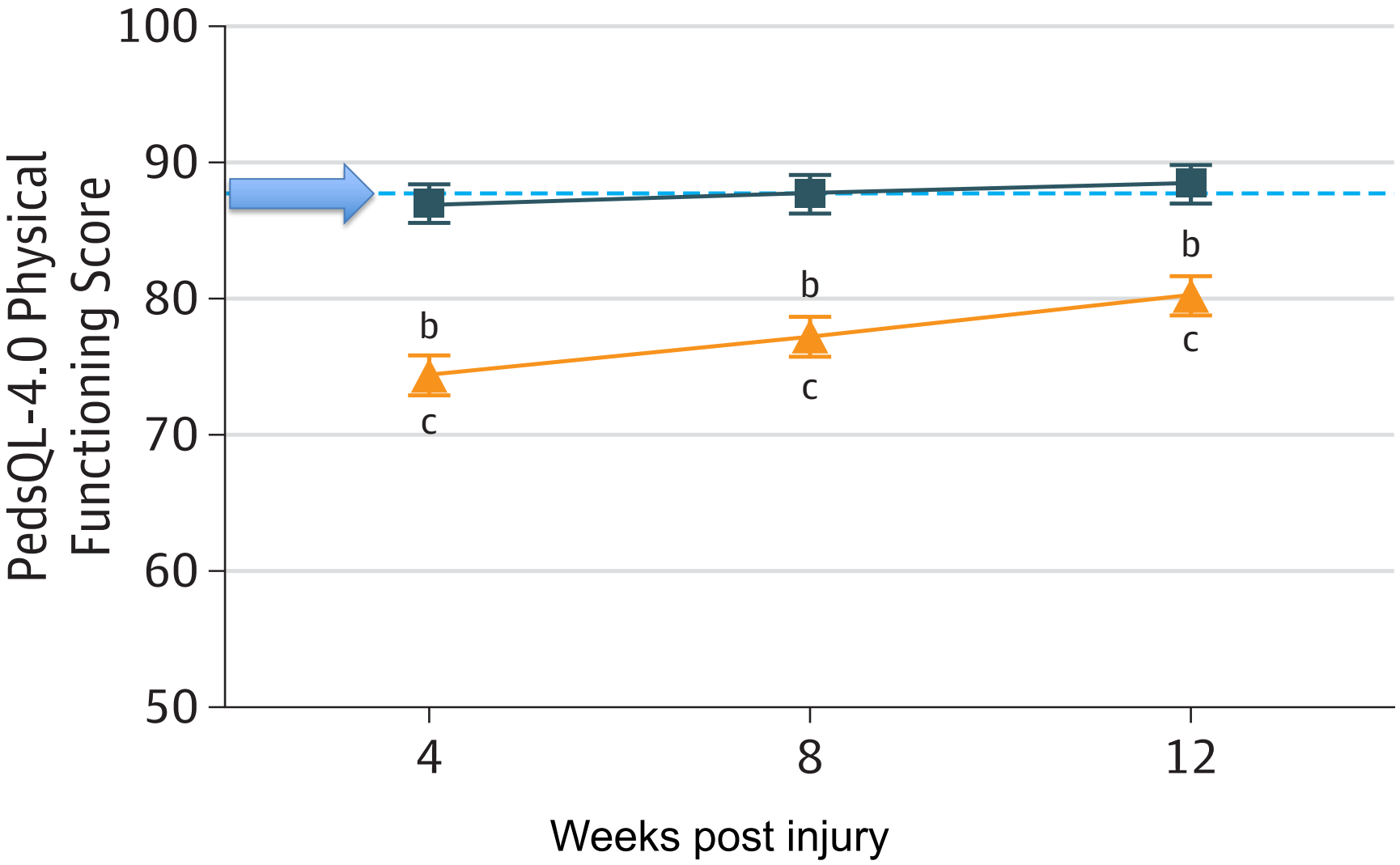
Zemek, et al. Journal of Pediatrics, 2016

The Questions Parents Ask

1) When will my child be better?

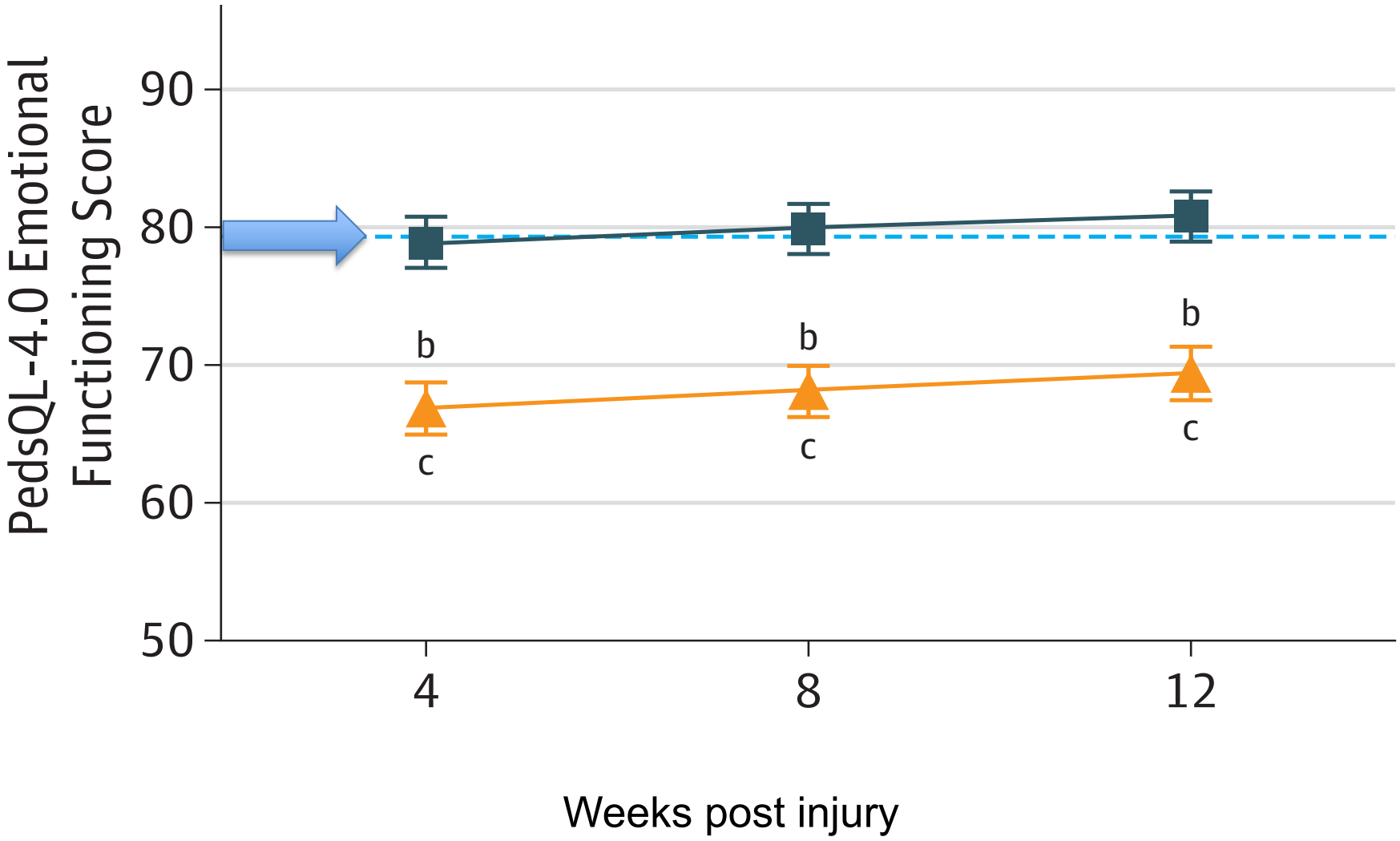
2) When will my child be able to return to sport?

QoL: Physical



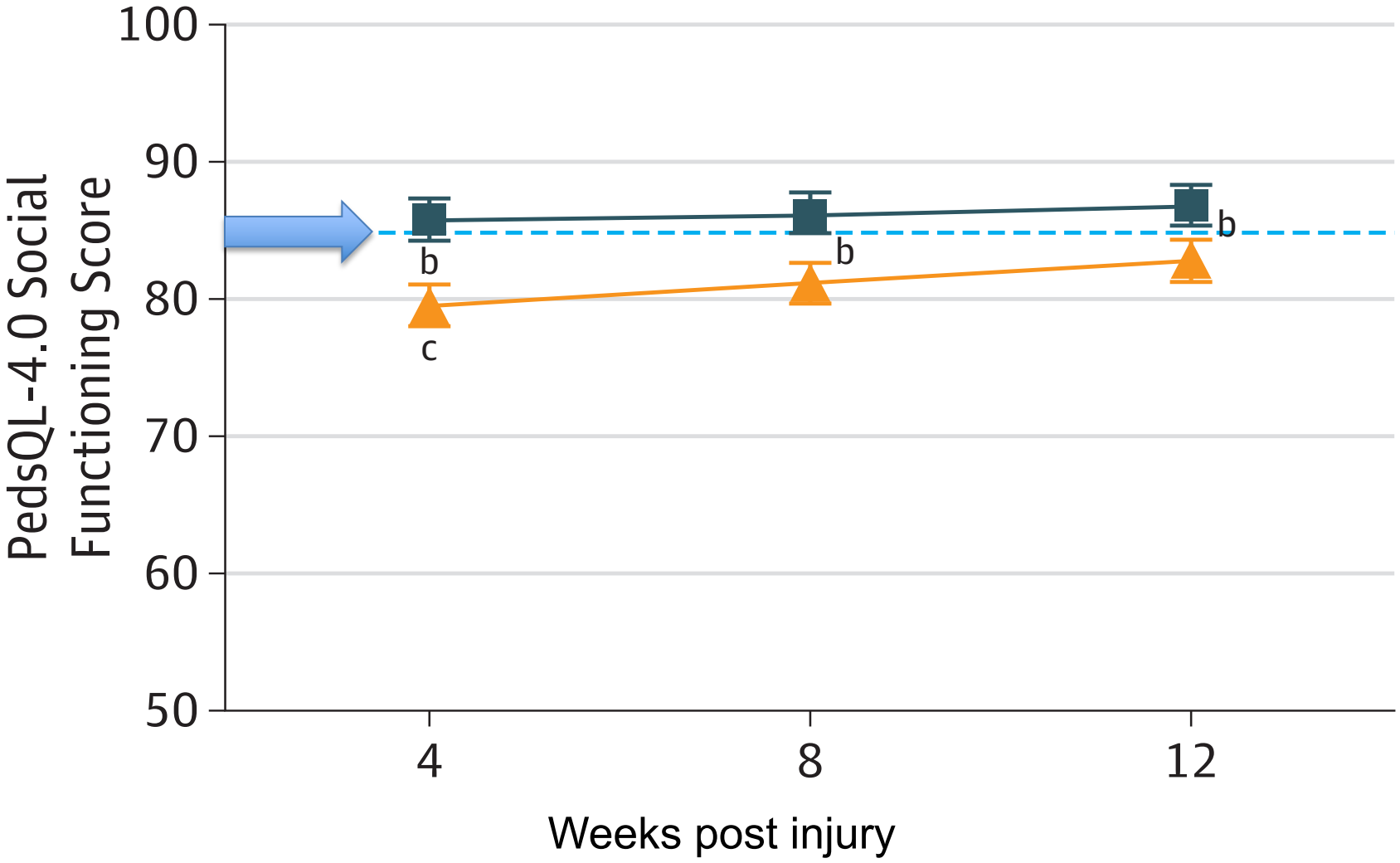
Novak et al. JAMA Pediatrics, 2016

QoL: Emotional



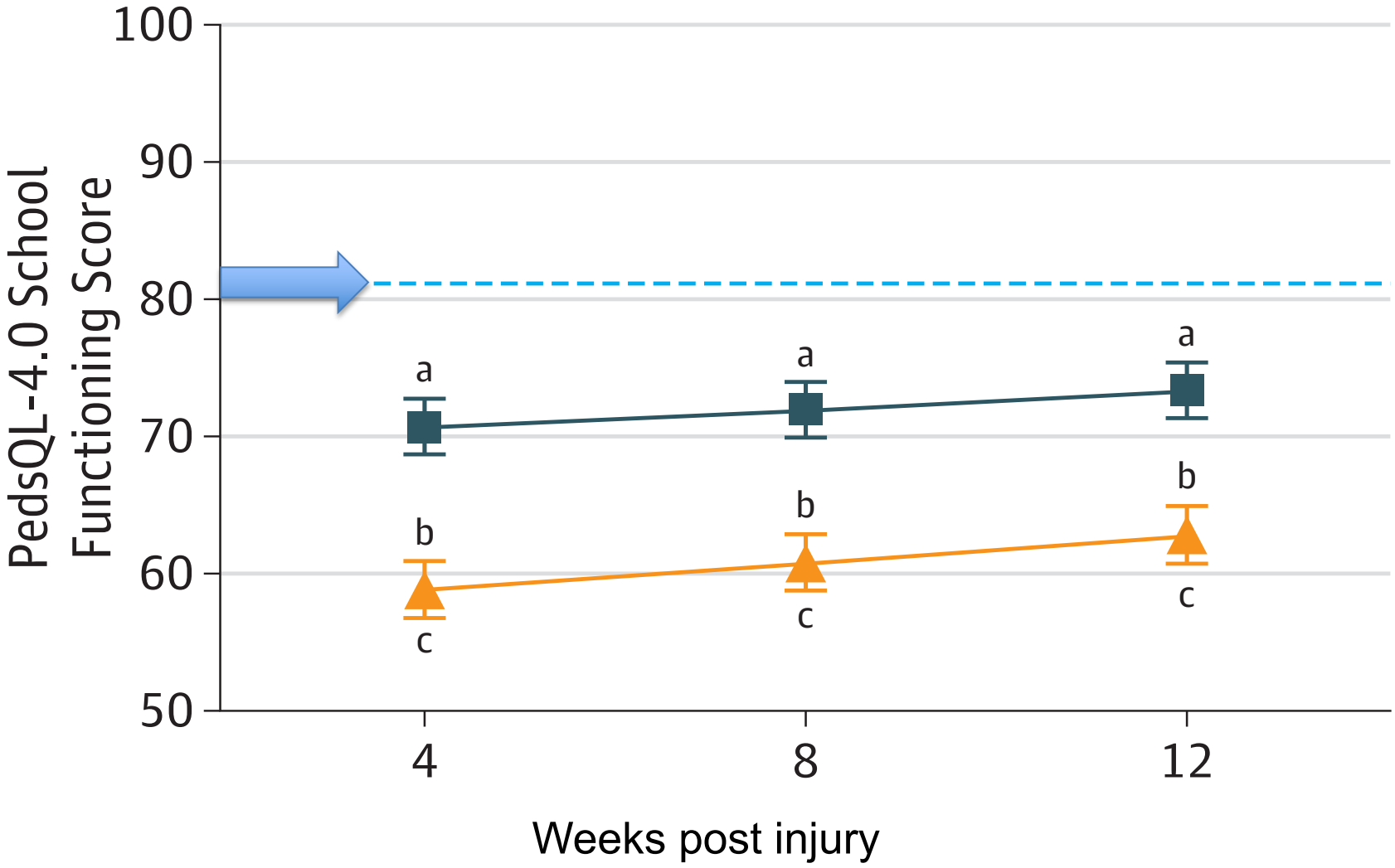
Novak et al. JAMA Pediatrics, 2016

QoL: Social



Novak et al. JAMA Pediatrics, 2016

QoL: School



Novak et al. JAMA Pediatrics, 2016

Why try to predict PPCS?

- Realistic anticipatory guidance
- Improved adherence to guidelines
- Target those at risk for specialized treatments
  - Follow-up with interdisciplinary concussion team
  - Medications or other novel interventions

Goal: to derive a clinical prediction rule for PPCS of *clinically available* factors in children presenting to the ED following concussion.

PCS Incidence (Derivation)

	Met PPCS criteria
Week 1	956/1716 (**56%**)
Week 2	697/1707 (**41%**)
Week 4	510/1701 (**30%**)
Week 8	382/1606 (**24%**)
Week 12	306/1573 (**20%**)

Risk Factor	Categories	Points
Age Group	5 to 7 8 to 12 13 to 18	0 1 2
Sex	Male Female	0 2
Longest Symptom Duration	No Prior or <1 week 1+ week	0 1
Personal History of Migraine	No Yes	0 1
Answers Questions Slowly	No Yes	0 1
Tandem Stance	0-3 4+, or unable to do test	0 1
Headache	No Yes	0 1
Sensitivity to Noise	No Yes	0 1
Fatigue	No Yes	0 2

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Journal of the
American Medical Association

Original Investigation

Clinical Risk Score for Persistent Postconcussion Symptoms Among Children With Acute Concussion in the ED

Roger Zemek, MD; Nick Barrowman, PhD; Stephen B. Freedman, MDCM, MSc; Jocelyn Gravel, MD; Isabelle Gagnon, PhD; Candice McGahern, BA; Mary Aglipay, MSc; Gurinder Sangha, MD; Kathy Boutis, MD; Darcy Beer, MD; William Craig, MDCM; Emma Burns, MD; Ken J. Farion, MD; Angelo Mikrogianakis, MD; Karen Barlow, MD; Alexander S. Dubrovsky, MDCM, MSc; Willem Meeuwisse, MD, PhD; Gerard Gioia, PhD; William P. Meehan III, MD; Miriam H. Beauchamp, PhD; Yael Kamil, BSc; Anne M. Grool, MD, PhD, MSc; Blaine Hoshizaki, PhD; Peter Anderson, PhD; Brian L. Brooks, PhD; Keith Owen Yeates, PhD; Michael Vassilyadi, MDCM, MSc; Terry Klassen, MD; Michelle Keightley, PhD; Lawrence Richer, MD; Carol DeMatteo, MSc; Martin H. Osmond, MDCM; for the Pediatric Emergency Research Canada (PERC) Concussion Team

IMPORTANCE Approximately one-third of children experiencing acute concussion experience ongoing somatic, cognitive, and psychological or behavioral symptoms, referred to as persistent postconcussion symptoms (PPCS). However, validated and pragmatic tools enabling clinicians to identify patients at risk for PPCS do not exist.

OBJECTIVE To derive and validate a clinical risk score for PPCS among children presenting to the emergency department.

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JAMA Report Video at jama.com

Supplemental content at jama.com

CME Quiz at jamanetworkcme.com and CME Questions page 1050

Natural Progression

JAMA Pediatrics | Original Investigation

Natural Progression of Symptom Change and Recovery From Concussion in a Pediatric Population

Andrée-Anne Ledoux, PhD; Ken Tang, PhD; Keith O. Yeates, PhD; Martin V. Pusic, MD, PhD; Kathy Boutis, MD; William R. Craig, MDCM, MSc; Jocelyn Gravel, MD; Stephen B. Freedman, MDCM, MSc; Isabelle Gagnon, PhD; Gerard A. Gioia, PhD; Martin H. Osmond, MDCM; Roger L. Zemek, MD; for the Pediatric Emergency Research Canada (PERC) Concussion Team

- Symptom improvement in first 2 weeks post-injury (children)
- Preadolescents and male adolescents in in the first 4 weeks
- Female adolescents have protracted recovery

January 2019, JAMA Pediatrics

Figure 1. Association of Sex and Continuous Age With Symptom Change Score Over Time (Measured in Weeks After Emergency Department Visit)

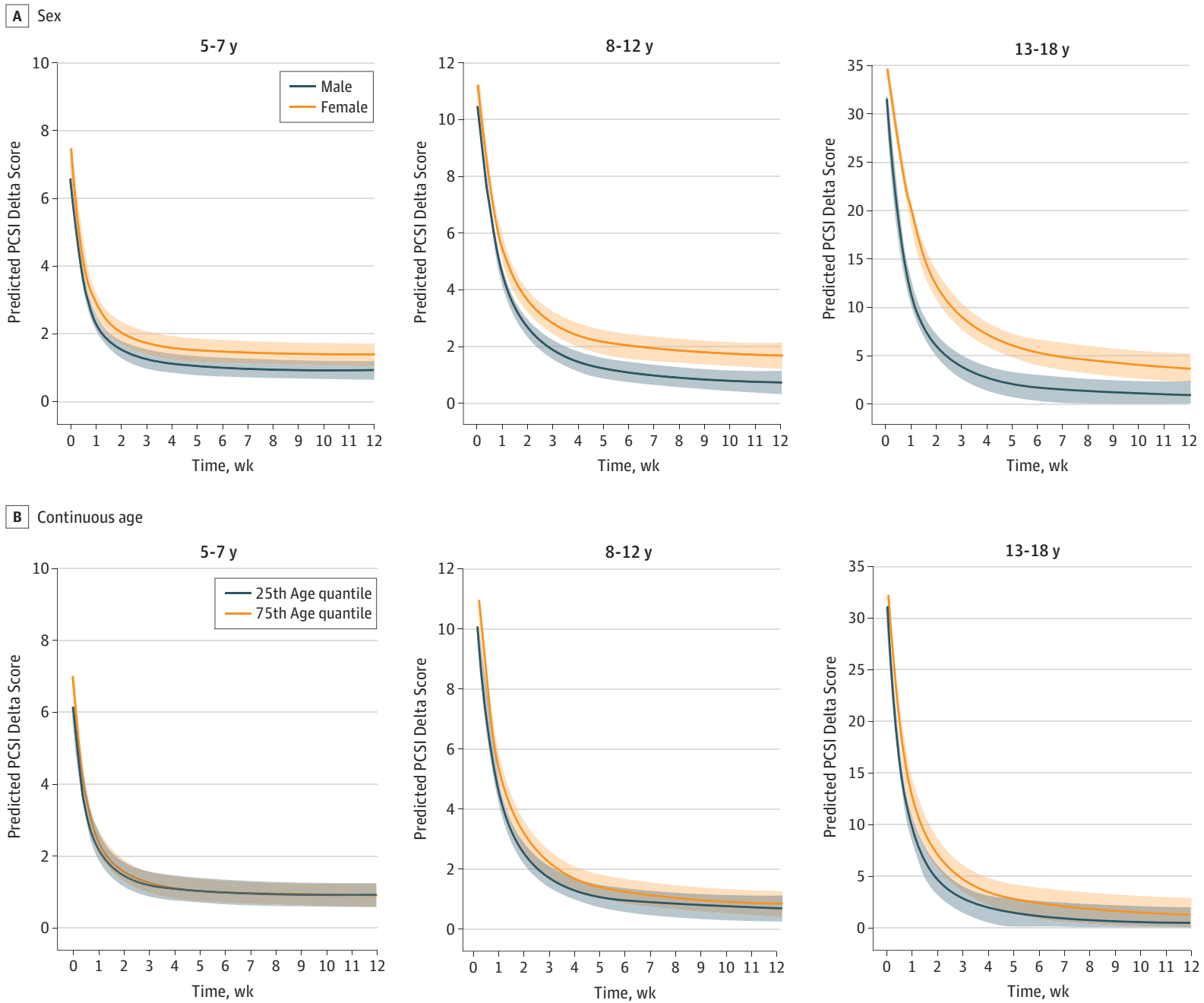
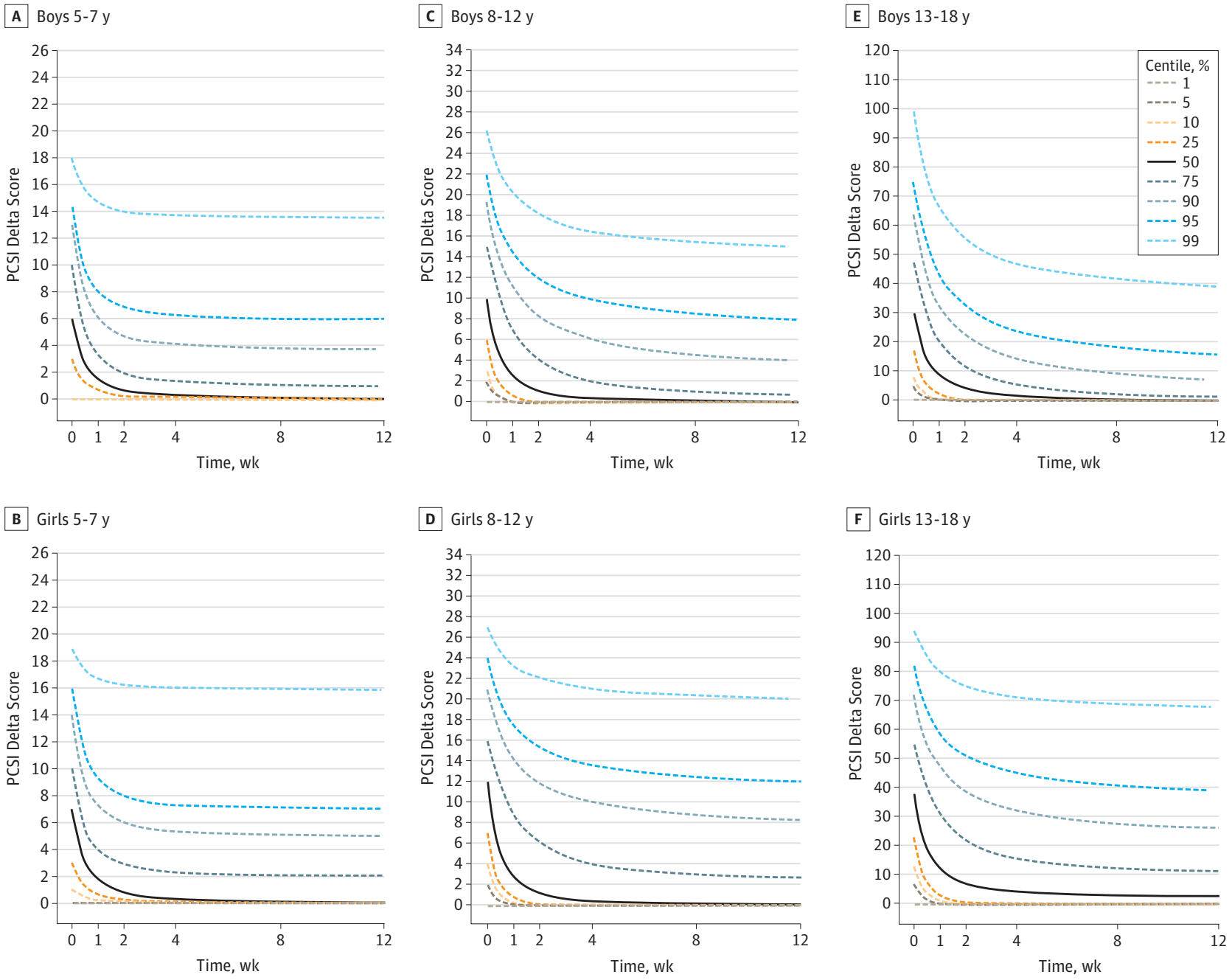


Figure 2. Unadjusted Recovery Centile Curves at Different Time Points, Stratified by Age Group and Sex

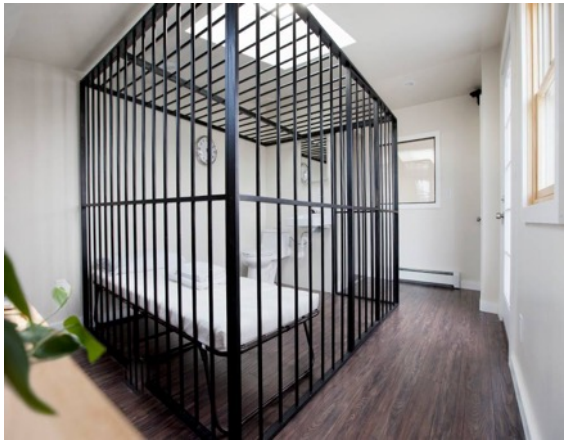


The Questions Parents Are Sure To Ask

1) When will my child be better?

2) When will my child be able to return to physical activities?

What happens now?



We <u>can</u> and <u>need</u> to do better!

Early Physical Activity

- Early return to physical activity was associated with reduced PPCS (29% vs. 40%)
- Most children non-compliant with current physical activity/rest recommendations
- ***RCTs urgently needed to confirm findings and determine optimal timing, duration and intensity***

Grool, et al. JAMA, 2016

jama.com

December 20, 2016
Volume 316, Number 23
Pages 2447-2560

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JAMA | Original Investigation

Association Between Early Participation in Physical Activity Following Acute Concussion and Persistent Postconcussive Symptoms in Children and Adolescents

Anne M. Grool, MD, PhD; Mary Aglipay, MSc; Franco Momoli, PhD; William P. Meehan III, MD; Stephen B. Freedman, MDCM, MSc; Keith Owen Yeates, PhD; Jocelyn Gravel, MD; Isabelle Gagnon, PhD; Kathy Boutis, MD; Willem Meeuwisse, MD, PhD; Nick Barrowman, PhD; Andrée-Anne Ledoux, PhD; Martin H. Osmond, MDCM; Roger Zemek, MD; for the Pediatric Emergency Research Canada (PERC) Concussion Team

IMPORTANCE Although concussion treatment guidelines advocate rest in the immediate postinjury period until symptoms resolve, no clear evidence has determined that avoiding physical activity expedites recovery.

OBJECTIVE To investigate the association between participation in physical activity within 7 days postinjury and incidence of persistent postconcussive symptoms (PPCS).

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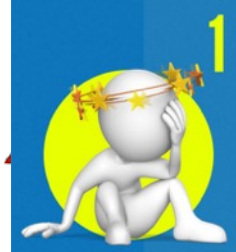
Author Video Interview and JAMA Report Video

CME Quiz at jamanetworkcme.com

Consensus Statement on Concussion in Sport

Reference: by McCrory P. et al. BJSM 2017

Graduated Return-to-Sport Strategy



1 Medical Assessment

2 Rest

Respect 24-48 hours of physical and cognitive rest until the symptoms at rest disappear

3 Symptom Limited Activity

- 10 min of slow walking
- No resistance training
- No contact activity allowed

4 Light Exercise

- Increase heart rate
- Walking, swimming or stationary cycling
- 20min at 70% HRmax
- No resistance training
- No contact activity

6 Non Contact Training

- Add coordination & cognitive skills
- Progression to more complex training drills
- 60min at 90% HRmax
- Resistance training OK
- No contact activity

5 Sports Specific Exercise

- Add movement
- Simple movement activities e.g. Running drills
- 30min at 80% HRmax
- No resistance training
- No contact activity

7 Medical Clearance

8 Full Contact Practice

- Restore confidence and function
- Normal training
- Contact activity OK

9 Return to Sport

- Unrestricted practice
- Normal game play
- Full rehabilitation

Designed by ©YLMSportScience

5th International Consensus Conference on Concussion in Sport

27 – 28 October 2016
Berlin, Germany

FIFA

perc
Pediatric Emergency Research Canada

JAMA Pediatrics | Original Investigation

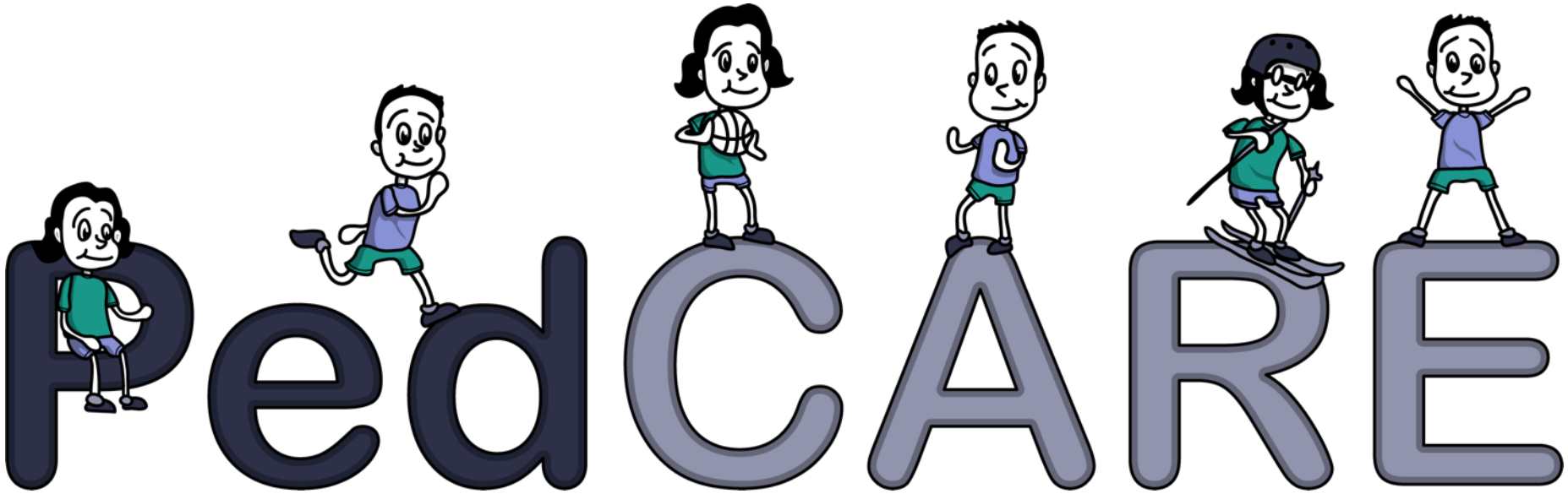
Early Subthreshold Aerobic Exercise for Sport-Related Concussion
A Randomized Clinical Trial

John J. Leddy, MD; Mohammad N. Haider, MD; Michael J. Ellis, MD; Rebekah Mannix, MD; Scott R. Darling, MD; Michael S. Freitas, MD; Heidi N. Suffoletto, MD; Jeff Leiter, PhD; Dean M. Cordingley, MSc; Barry Willer, PhD

IMPORTANCE Sport-related concussion (SRC) is a significant public health problem without an effective treatment.

OBJECTIVE To assess the effectiveness of subsymptom threshold aerobic exercise vs a placebo-like stretching program prescribed to adolescents in the acute phase of recovery from SRC.

DESIGN, SETTING, AND PARTICIPANTS This multicenter prospective randomized clinical trial was conducted at university concussion centers. Male and female adolescent athletes (age 13-18 years) presenting within 10 days of SRC were randomly assigned to aerobic exercise or a placebo-like stretching regimen.



Pediatric Concussion Assessment of Rest and Exertion

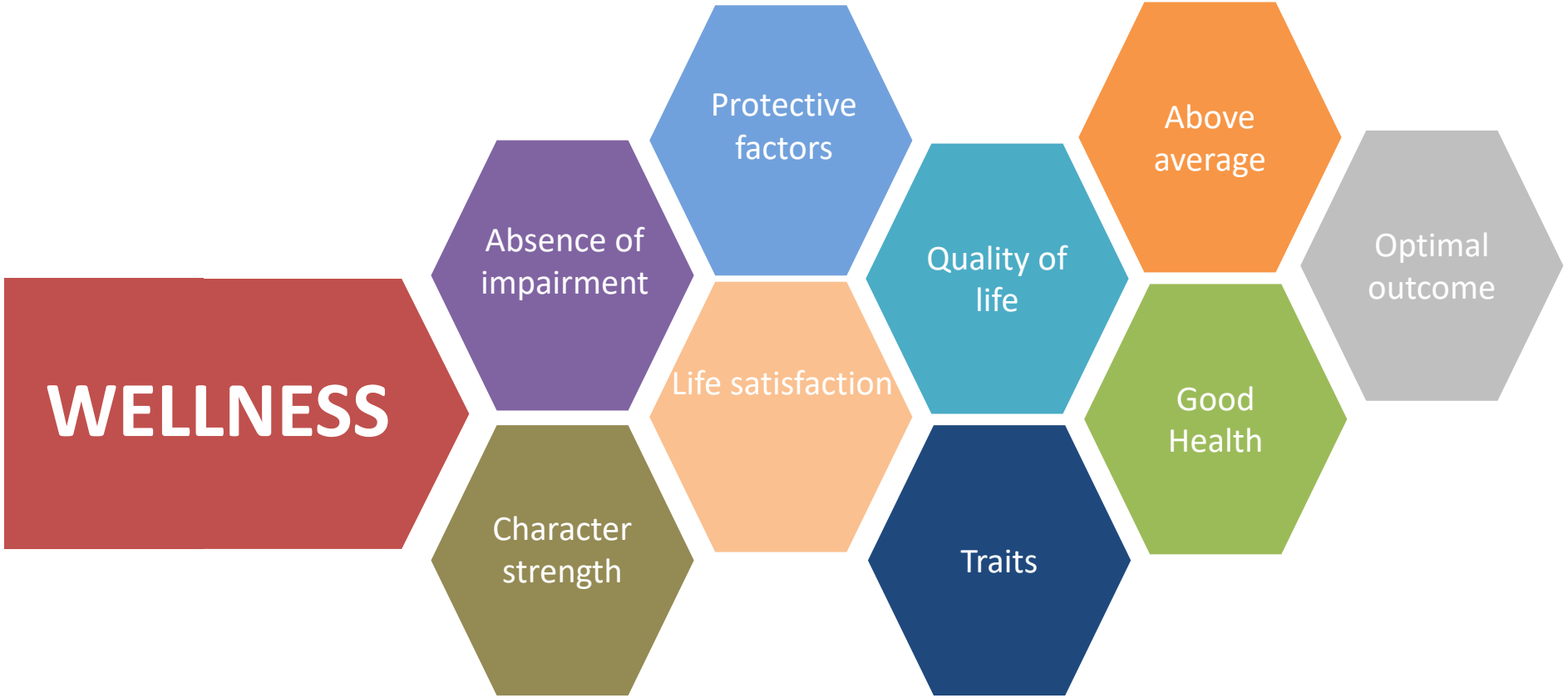
Ledoux A-A, et al. Br J Sports Med, 2017

Holland Bloorview Kids Rehabilitation Hospital | Concussion Centre | CanChild | Children's Hospital London Health Sciences Centre | SickKids THE HOSPITAL FOR SICK CHILDREN | CHEO

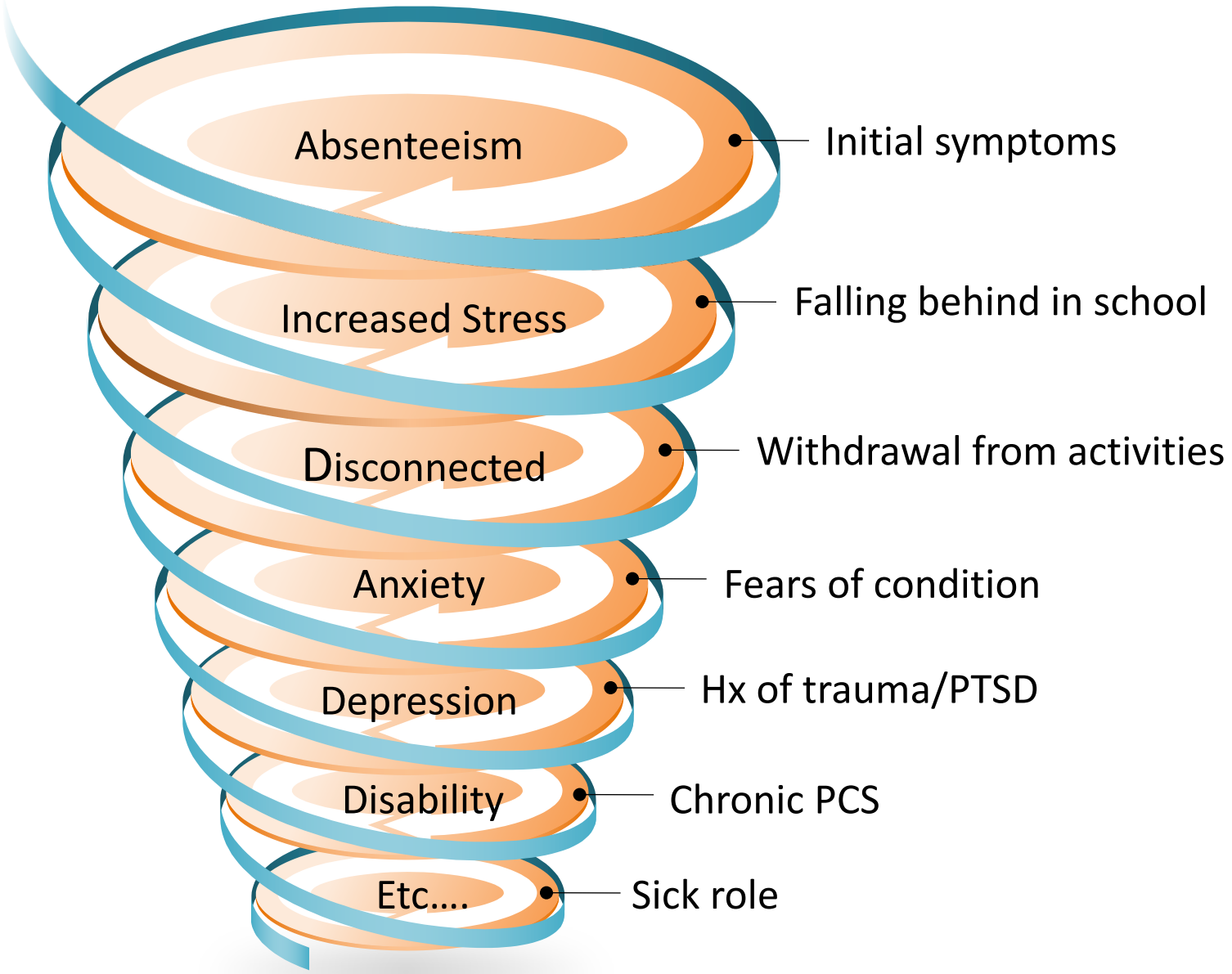
Wellness Definition

*"...a state of complete physical, mental, and social well-being, and **not merely the absence of disease or infirmity**"*

- World Health Organization



Downward Spiral of Mental Health



Collaborative Care Model

Collaborative Care for Adolescents With Persistent Postconcussive Symptoms: A Randomized Trial

Carolyn A. McCarty, PhD,[a,b] Douglas Zatzick, MD,[c,d] Elizabeth Stein, BA,[a] Jin Wang, PhD, MS,[d] Robert Hilt, MD,[c,e] Frederick P. Rivara, MD, MPH,[a,b,d] for the Seattle Sports Concussion Research Collaborative

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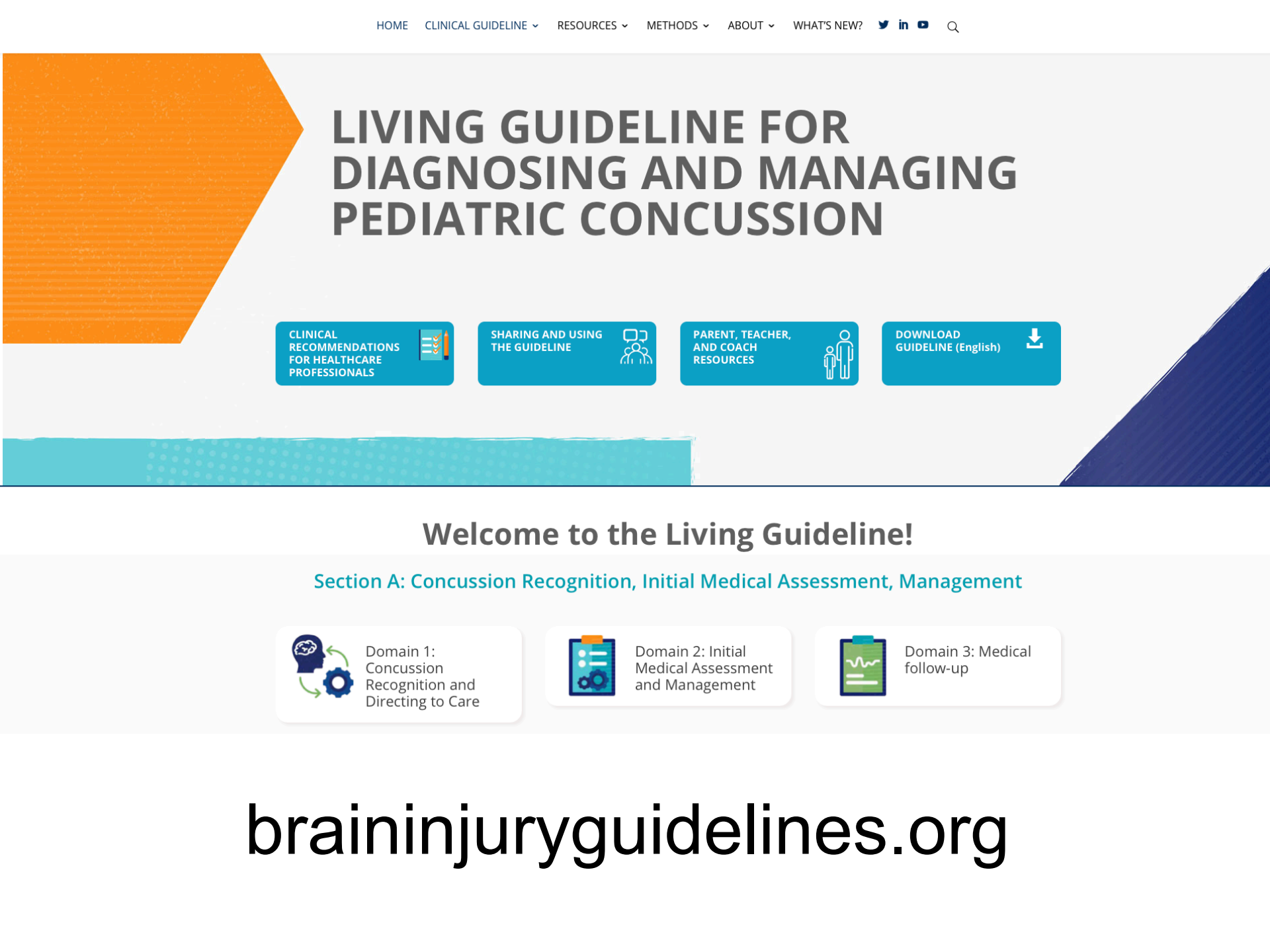
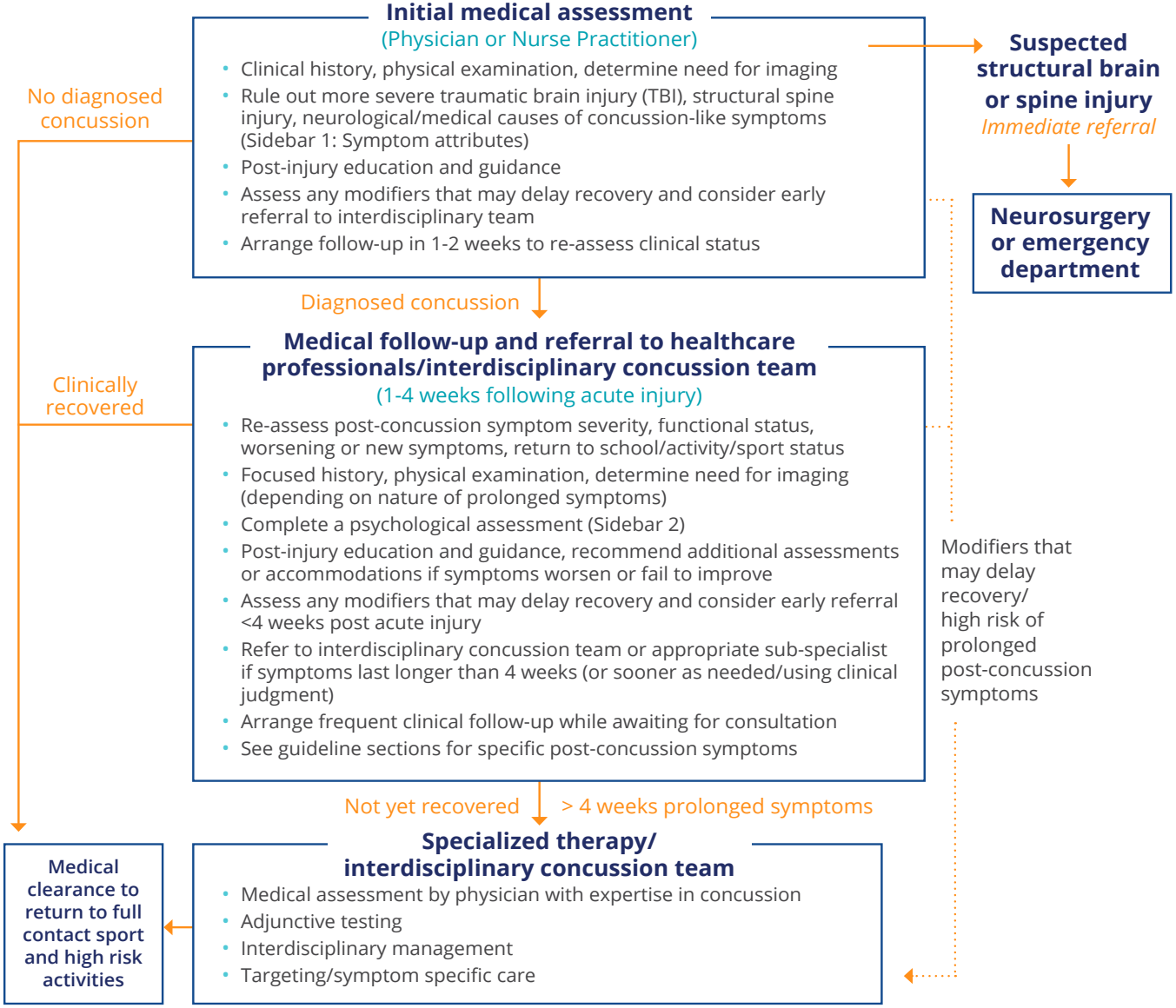


braininjuryguidelines.org

TOOL 1.2: Manage Acute and Prolonged Concussion Symptoms Algorithm



Links to Recommendations:

1: Recognition and directing to care
2: Initial medical assessment and management
3: Medical follow-up
4: Medical clearance: Full contact sport or high-risk activity
5: Sport concussion considerations
6: Post-traumatic headache
7: Sleep disturbances
8: Mental health
9: Cognitive problems
10: Vision/vestibular/ oculomotor
11: Fatigue
12: Return to school/work

SIDEBAR 1

> Symptom attributes

- Duration, onset, triggers, location
- Intensity and impact
- Perception of symptoms
- Impact on functioning
- Previous episodes
- Previous treatment and response

SIDEBAR 2

> Psychosocial evaluation

- Support system
- Mental health history
- Comorbid conditions (chronic pain, mood/ stress/personality disorder)
- Substance use disorder
- Absence from school or academic difficulties

Adapted with permission from the Ontario Neurotrauma Foundation Standards for Post-Concussion Care - Post Concussion Care Pathway

Recommendations

LEVEL OF EVIDENCE A B C

8.1

Assess existing and new mental health symptoms and disorders.

Level of Evidence: A

Experienced and trained healthcare professionals should use appropriate screening tools to assess the child/adolescent. These assessments should be considered for children/adolescents with a history of mental health problems or with prolonged post-concussive symptoms.

Use Tool 8.1: Post-concussion mental health considerations algorithm and refer to a mental health specialist using clinical judgment.

Assessment screening tools to consider (direct website links):

- Link: PHQ-SADS (somatic)
- Link: Severity Measure for Depression- Child Age 11–17 (adapted from PHQ-9 modified for Adolescents [PHQ-A])
- Link: Severity Measure for Generalized Anxiety Disorder-Child Age 11–17 (adapted from GAD-7)
- Link: HEADS-ED Tool—Screening for Pediatric Mental Health (online interactive tool)
- Link: PROMIS Anxiety (pediatric and parent versions are available via HealthMeasures.net)
- Link: PROMIS Depression (pediatric and parent versions are available via HealthMeasures.net)
- Link: PROMIS Profile (25 questions, 37 questions, 49 questions versions are available via HealthMeasures.net)

Summary

- Increasing incidence of concussion
- Identify the predictors for PPCS (5P rule)
- Potential to individualize concussion care
  - Appropriate follow-up (timing and type)
  - Target for early novel intervention
- Early physical activity important for recovery
- Braininjuryguidelines.org
- Many more questions still to answer!

CHEO

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Celebrating children: 100 years of care

Darcy Beer, MD
Terry Klassen, MD

Boston Children's Hospital
Until every child is well

Bill Meehan, MD