



Joe DiMaggio  
Children's Hospital

CONCUSSION CLINIC

# ***Return to Play after Concussion: Youth vs. Professional Protocols***

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[U18] Sports Medicine

# Disclosures

I have no personal financial or other relationships, conditions, and/or circumstances that present potential conflicts of interest.

# Definition/Diagnosis

## Functional Injury

- **Concussion** is a disturbance in brain function caused by a direct or indirect force to the head. It results in a variety of non-specific signs and / or symptoms.
- Rotational mechanism
- Concussion should be suspected and the appropriate management strategy instituted in the presence of **any one or more** of the following:
  - Symptoms somatic (e.g., headache), cognitive (e.g., feeling like in a fog) and/or emotional
  - Physical signs (e.g., unsteadiness)
  - Cognitive Impairment (e.g. confusion, slowed reaction times)
  - Abnormal behavior (e.g., change in personality, irritability)
  - Sleep disturbance (eg insomnia)

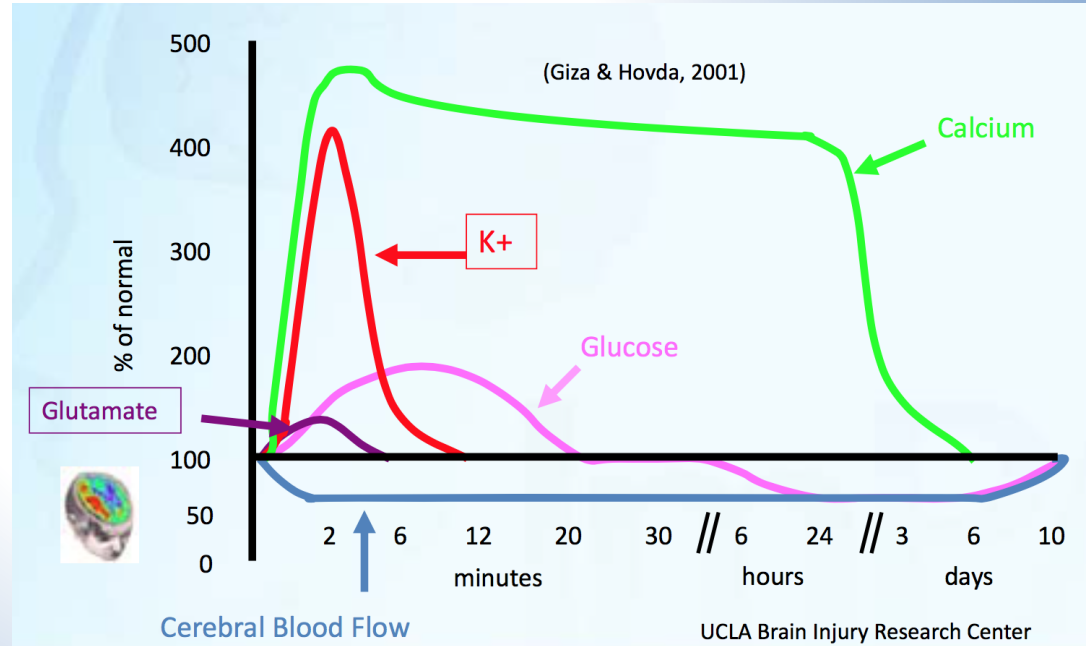
*Consensus statement on concussion in sport. McCrory P, et al. Clin J Sport Med. 2013*

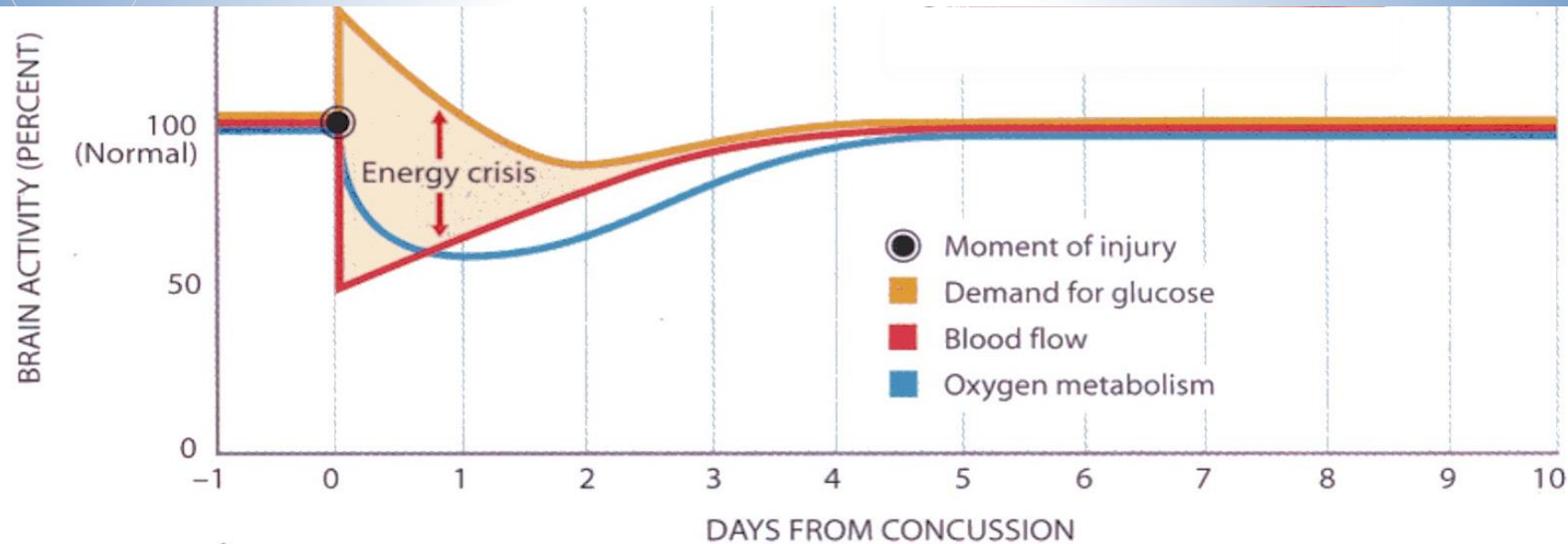
# Pathophysiology

- Cellular level - Flood of neurotransmitters from trauma
- **Ion flux**  
(efflux of  $K^+$ , influx of  $Ca^{2+}$ )
- Depolarization – spreading depression
- Intracellular Glucose delivery interrupted  
Decreased flow with increased demand
- Creates metabolic dysfunction and cell vulnerability leading to symptoms  
**“Energy Crisis”**

# Pathophysiology

## Neurometabolic Cascade Following Cerebral Concussion/mTBI





# Phased Management

1. **Aggressive Rest\***
2. **Return to Learn**
3. **Return to Activity**
4. **Return to Play**

# Return to Play

- Resolution of symptoms at rest
- Academic tolerance
- Exercise tolerance
- Neurocognitive test results



# RTP History – Original Cantu 1980s

Guideline	Grade 1	Grade 2	Grade 3
Cantu [6]	1. No loss of consciousness 2. Posttraumatic amnesia lasts less than 30 minutes	1. Loss of consciousness lasts longer than 5 minutes OR 2. Posttraumatic amnesia lasts longer than 30 minutes	1. Loss of consciousness lasts longer than 5 minutes OR 2. Posttraumatic amnesia lasts longer than 24 hours

- Allowed RTP same day of injury if the athlete was symptom-free both at rest and following physical exertion.
- Any loss of consciousness, a restriction of contact for 1 month.
- Athletes who had suffered a grade 2 concussion were allowed to return to play in 2 weeks if asymptomatic for a period of 7 days.

# RTP History – Colorado Guidelines 1991

## Colorado [23]

1. Confusion without amnesia
2. No loss of consciousness

1. Confusion with amnesia
2. No loss of consciousness

1. Loss of consciousness (of any duration)

- Allowed for same-day RTP if symptoms cleared within 20 minutes of injury.
- For more severe injury, the guidelines recommended immediate transport to a hospital for further evaluation.

# RTP History – AAN Colorado Revision

American Academy  
of Neurology [1]

1. Transient confusion
2. No loss of consciousness
3. Concussion symptoms, mental status changes resolve in less than 5 minutes

1. Transient confusion
2. No loss of consciousness
3. Concussion symptoms, mental status change lasts longer than 15 minutes

1. Loss of consciousness (brief or prolonged)

- Allowed RTP the same day of injury if the athlete's signs and symptoms cleared within 15 minutes of injury.
- Grade 2 concussion was managed in a manner similar to the original Colorado guidelines, with return to competition within 1 week if asymptomatic

# RTP History – Cantu Revision 2001

- Same-day RTP was allowed only if the athlete was completely asymptomatic following the injury

## RTP History

- AOSSM – late 90s
- FIFA/IOC CISG – 2001/2002 Vienna first consensus statement to most recent Berlin 2016/2017
  - (planned update before Dec 31 2020)

# RTP Physiologic Basis

Blakemore SJ, Burnett S, Dahl RE. The role of puberty in the developing adolescent brain. *Hum Brain Mapp.* 2010;31(6):926-933.

Blakemore SJ, Choudhury S. Development of the adolescent brain: implications for executive function and social cognition. *J Child Psychol Psychiatry.* 2006;47(3-4):296-312.

- Gray matter has been shown to increase in the brain during **childhood** but then reaches a peak in **adolescence**, plateaus, and decreases through **adulthood**.
- During **adolescence**, the brain undergoes a structural reorganization in which **white matter increases** and **gray matter peaks**.
- ***These changes in brain development may result in increases in reported cognitive deficiencies.***

# RTP Physiologic Basis

- The **immature brain** may be up to 60 times more sensitive to glutamate
  - Neurotransmitter involved in the metabolic cascade following concussion

McDonald JW, Johnston MV. Physiological and pathophysiological roles of excitatory amino acids during central nervous system development. Brain Res Brain Res Rev 1990;15:41-70

# RTP Physiologic Basis

**High school** football athletes reported the highest number of symptoms and the ***longest return-to-play time***

Kerr ZY, Zuckerman SL, Wasserman EB, Covassin T, Djoko A, Dompier TP. Concussion Symptoms and Return to Play Time in Youth, High School, and College American Football Athletes. *JAMA Pediatr.* 2016;170(7):647–653. doi:10.1001/jamapediatrics.2016.0073

Zuckerman SL, Lee YM, Odom MJ, Solomon GS, Forbes JA, Sills AK. Recovery from sports-related concussion: days to return to neurocognitive baseline in adolescents versus young adults. *Surg Neurol Int.* 2012;3:130. doi:10.4103/2152-7806.102945.

Williams RM, Puetz TW, Giza CC, Broglio SP. Concussion recovery time among high school and collegiate athletes: a systematic review and meta-analysis. *Sports Med.* 2015;45(6):893-903.

Foley C, Gregory A, Solomon G. Young age as a modifying factor in sports concussion management: what is the evidence? *Curr Sports Med Rep.* 2014;13(6):390-394.

# RTP Physiologic Basis - Childhood

- Child athletes take longer to recover from concussions than adults.
- Concussion symptoms may resolve before cognitive function has completely recovered.

Purcell L

What are the most appropriate return-to-play guidelines for concussed child athletes?

*British Journal of Sports Medicine* 2009;**43**:i51-i55.



# RTP Physiologic Basis

Table 4. Return-to-Play Time for Athletes With Concussions in Youth, High School, and College Football, 2012 to 2014 Seasons

Return-to-Play Time <sup>a</sup>	Level of Competition, No. (%)			
	Youth	High School	College	Pro MLB
Less than 24 h	8 (10.1)	7 (0.8)	19 (4.7)	
1 to 6 d	52 (29.2)	86 (10.4)	105 (26.2)	
7 to 13 d	59 (33.2)	294 (35.4)	180 (44.9)	
14 to 29 d	20 (11.2)	281 (33.9)	69 (17.2)	145
At least 30 d	29 (16.3)	162 (19.5)	28 (7.0)	219 (15.5)
Missing	4	5	11	20
Total	178 (100.0)	830 (100.0)	401 (100.0)	1409 (100.0)

<sup>a</sup> Missing data are not included in calculations of percentages. Data originate from the Youth Football Surveillance System for youth; National Athletic Treatment, Injury, and Outcomes Network for high school; and National Collegiate Athletic Association Injury Surveillance Program for college, 2012 to 2014 seasons.

Kerr ZY, Zuckerman SL, Wasserman EB, Covassin T, Djoko A, Dompier TP. Concussion Symptoms and Return to Play Time in Youth, High School, and College American Football Athletes. *JAMA Pediatr.* 2016;170(7):647–653. doi:10.1001/jamapediatrics.2016.0073

# RTP Physiologic Basis

***Should we be keeping our youth athletes out longer?***

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	

- **NOTE: An initial period of 24–48 hours of both relative physical rest and cognitive rest is recommended before beginning the RTS progression.**
- **There should be at least 24 hours (or longer) for each step of the progression. If any symptoms worsen during exercise, the athlete should go back to the previous step. Resistance training should be added only in the later stages (stage 3 or 4 at the earliest). If symptoms are persistent (eg, more than 10–14 days in adults or more than 1 month in children), the athlete should be referred to a healthcare professional who is an expert in the management of concussion.**

# RTP Professional and Collegiate Athlete

- All athletes, regardless of level of participation, should be managed using the same management principles noted in the previous protocol.

McCrory P, Meeuwisse W, Dvorak J, *et al*  
Consensus statement on concussion in  
sport—the 5<sup>th</sup> international conference on  
concussion in sport held in Berlin, October  
2016  
*Br J Sports Med* 2017;**51**:838-847.

## RTP Youth Athlete

- RTP decisions in children should be made cautiously and should be individualized
- Youth athletes should remain symptom free for several days (***Double the Duration***) before starting a medically supervised stepwise exertion protocol

# Prevention Youth Athlete

HANS Device

Periscapular and Postural (Neck) Stabilization

Fair Play and Age/Skill/Size matching

No evidence for helmet brand/type, mouth-guards





*Thank you*

Questions?



Joe DiMaggio  Children's Hospital

## Concussion Clinic

We're your team for expert concussion care.

**954-538-5566**

If you think your child has a concussion – a mild traumatic brain injury –  
**seek immediate medical attention.**



Whether it's a sports-related or non-sports-related concussion, count on us to deliver quality, coordinated care.

We help navigate and expedite appointments with the right pediatric specialists to meet your child's needs:

- Pediatric Sports Medicine
- Pediatric Physical Medicine and Rehabilitation
- Pediatric Neurology
- Pediatric Neuropsychology
- Pediatric Vestibular Rehabilitation
- Pediatric Neurosurgery