

*Erik Adler,  
MD*

# **Sports Related Concussions and Stingers**

*Rocky Mountain Trauma  
Conference  
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# Disclosures

I have no actual or potential conflict of interests in relation to this presentation.

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# Goals

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- Definition
- Emergency Dept workup
- Assessment tools
- Removal from play
- Return to play algorithm
- Current state of research
  - Labs
  - Imaging
- Case



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# Definition

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- A traumatic brain injury involving temporary loss of brain function. It is caused by a direct blow to the head, face, or neck that applies force to the brain within the skull.
  - Headache or pressure in the head
  - Nausea or vomiting
  - Balance problems or dizziness
  - Double or blurry vision
  - Bothered by light or noise
  - Feeling sluggish, hazy, foggy or groggy
  - Confusion, concentration, or memory issues
  - Just not feeling right
  - Loss of consciousness not required

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# Why we care

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- Bleeding
- Associated injuries
- Cumulative effects of repeated concussions
- Long term effects
  - Dementia
  - Alzheimer's
  - Parkinson's
  - Depression
- Second impact syndrome



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# Second Impact Syndrome

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- 2nd head injury that occurs before symptoms from first injury have cleared
- Can be remarkably minor
- Loss of autoregulation of the brain's blood supply
  - Vascular engorgement
  - Increased ICP
  - Brain Herniation
  - Brainstem failure (can be extremely rapid- seconds to minutes)
  - 50% mortality

Removal from play is  
key!

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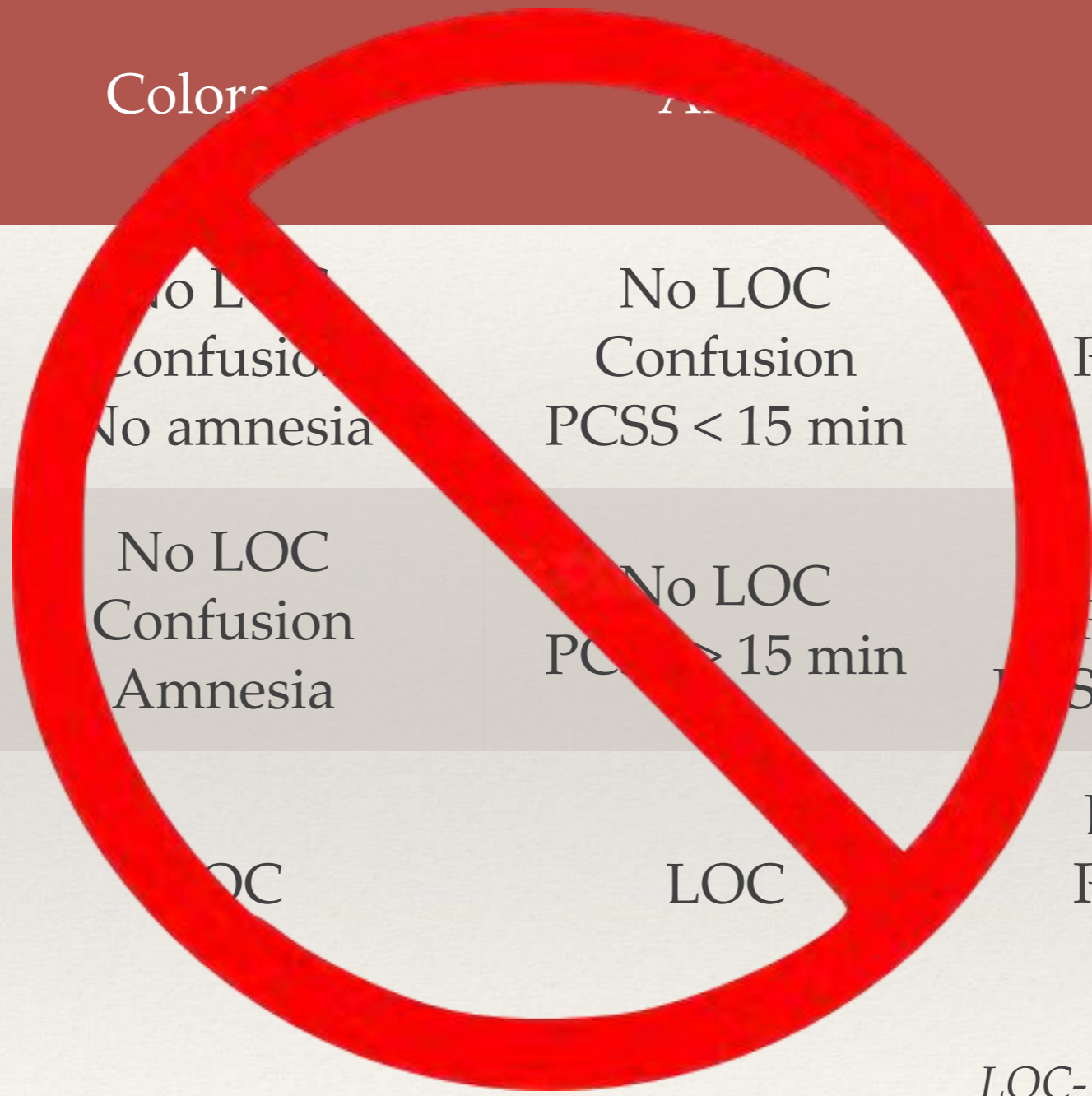
# Jake Snakenberg

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- Jake was a 15 yo male who died in 2004 from second impact syndrome. He played for Grandview High School in Aurora, CO
- In 2011, a new law bearing Jake's name was passed requiring concussion education for all coaches. If a coach suspects concussion, child must be removed from play for further evaluation.
- All high schools will have a concussion protocol for outpatient resource and referrals.

# Grading Systems

Grade	Colorado	AMA	Cantu
Grade I Mild	No LOC Confusion No amnesia	No LOC Confusion PCSS < 15 min	No LOC PTA < 30 min or PCSS < 30 min
Grade II Moderate	No LOC Confusion Amnesia	No LOC PCSS > 15 min	LOC < 5 min PTA > 30 min or PCSS > 30 min < 24 hrs
Grade III Severe	LOC	LOC	LOC > 5 min or PTA > 24 min or PCSS > 7 days



*LOC- loss of consciousness*  
*PTA- Post traumatic amnesia*  
*PCSS- Post concussion signs or symptoms*



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# Neurocognitive Testing

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- Post-Concussion Symptom Scale (PCSS)
- Standard Assessment of Concussion (SAC)
- Standard Concussion Assessment Tool (SCAT5)
- ACE (Acute concussion evaluation)
- Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT)

# ImPACT

- Computer based assessment
- Takes about 20 minutes
- Requires pre-injury assessment for comparison

## SYMBOL MATCHING

Evaluates visual processing speed, learning and memory

	□	○	+	∞	◇	↗	◐	△
1	2	3	4	5	6	7	8	9

Click on the number that corresponds to the following symbol:



Symbols are shown with corresponding numbers. As a symbol is displayed below, the subject must click on the matching number above. After 27 matches, the subject must remember the correct symbol-number pairing.

## DESIGN MEMORY

Evaluates attentional processes and visual recognition memory



Was this one of the designs displayed?

Yes

No

Twelve designs are presented for 750 milliseconds, twice to facilitate learning. The subject is then shown a series of correct and incorrect designs and asked if each was displayed previously.

## COLOR MATCH

Evaluates reaction time, impulse control/response inhibition

RED

BLUE

GREEN

Some words are displayed in their matching color (e.g. RED appears in a red color) and some do not (e.g. BLUE appears in a green color). The subject is instructed to quickly click on the word box only if the word and color match.

# ACE (acute concussion evaluation)

- Does not require pre-injury testing
- No computer required
- Highly reliable

## ACUTE CONCUSSION EVALUATION (ACE)

Emergency Department (ED) Version v1.4

Gerard Gioia, PhD<sup>1</sup> & Micky Collins, PhD<sup>2</sup>

<sup>1</sup>Children's National Medical Center

<sup>2</sup>University of Pittsburgh Medical Center

Patient Name \_\_\_\_\_  
 DOB: \_\_\_\_\_ Age: \_\_\_\_\_  
 Date: \_\_\_\_\_ ID/MR# \_\_\_\_\_

**A. Injury Characteristics** Date/Time of Injury \_\_\_\_\_ Reporter:  Patient  Parent  Spouse  Other \_\_\_\_\_

1. Injury Description \_\_\_\_\_

1a. Is there evidence of a forcible blow to the head (direct or indirect)?  Yes  No  Unknown

1b. Is there evidence of intracranial injury or skull fracture?  Yes  No  Unknown

1c. Location of Impact:  Frontal  Lft Temporal  Rt Temporal  Lft Parietal  Rt Parietal  Occipital  Neck  Indirect Force

2. Cause:  MVC  Pedestrian-MVC  Fall  Assault  Sports (specify) \_\_\_\_\_ Other \_\_\_\_\_

3. Amnesia Before (Retrograde) Are there any events just BEFORE the injury that you/ person has no memory of (even brief)?  Yes  No Duration \_\_\_\_\_

4. Amnesia After (Anterograde) Are there any events just AFTER the injury that you/ person has no memory of (even brief)?  Yes  No Duration \_\_\_\_\_

5. Loss of Consciousness: Did you/ person lose consciousness?  Yes  No Duration \_\_\_\_\_

6. EARLY SIGNS:  Appears dazed or stunned  Is confused about events  Answers questions slowly  Repeats Questions  Forgetful (recent info)

7. Seizures: Were seizures observed? No  Yes  Detail \_\_\_\_\_

**B. Symptom Check List\*** Since the injury, has the person experienced any of these symptoms any more than usual today or in the past day?

Indicate presence of each symptom (0=No, 1=Yes).

\*Lovell & Collins, 1998 JHTR

PHYSICAL (10)		COGNITIVE (4)		SLEEP (4)	
Headache	0 1	Feeling mentally foggy	0 1	Drowsiness	0 1
Nausea	0 1	Feeling slowed down	0 1	Sleeping less than usual	0 1 N/A
Vomiting	0 1	Difficulty concentrating	0 1	Sleeping more than usual	0 1 N/A
Balance problems	0 1	Difficulty remembering	0 1	Trouble falling asleep	0 1 N/A
Dizziness	0 1	<b>COGNITIVE Total (0-4)</b> _____		<b>SLEEP Total (0-4)</b> _____	
Visual problems	0 1	<b>EMOTIONAL (4)</b>			
Fatigue	0 1	Irritability	0 1		
Sensitivity to light	0 1	Sadness	0 1		
Sensitivity to noise	0 1	More emotional	0 1		
Numbness/Tingling	0 1	Nervousness	0 1		
<b>PHYSICAL Total (0-10)</b> _____		<b>EMOTIONAL Total (0-4)</b> _____			
(Add Physical, Cognitive, Emotion, Sleep totals)					
<b>Total Symptom Score (0-22)</b> _____					

Other Observations

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Patient Participation: Full  Partial  None

Reason for Partial/None: Young Age  Confused  Inattentive  Low arousal  Emotional Upset  In Pain  Other \_\_\_\_\_

**C. Concussion History:** Previous# 0 1 2 3 4 5 Date(s) \_\_\_\_\_

**Headache History:** Prior treatment for headache N  Y  Details \_\_\_\_\_

**D. Diagnosis (ICD):**  Concussion w/o LOC 850.0  Concussion w/ LOC 850.1  Concussion (Unspecified) 850.9  Other (854) \_\_\_\_\_  
 No diagnosis

**E. Follow-Up Action Plan**  Referral to PCP for Office Monitoring MD Name \_\_\_\_\_  
 Neuropsychological Testing (recommended for Return to Sport decisions and academic/ behavioral management)  
 Physician: Neurosurgery \_\_\_\_\_ Neurology \_\_\_\_\_ Sports Medicine \_\_\_\_\_ Physiatry \_\_\_\_\_ Psychiatry \_\_\_\_\_  
 Other \_\_\_\_\_

ACE-ED Completed by: \_\_\_\_\_ MD RN NP DO

A 2011 study showed that athletes who had taken a pre-season baseline ImPACT computerized neuropsychological test, and took the ImPACT test again after suspected concussion were less likely to return to play on the same day, and less likely to return to play within a week of their injury, than the three out of four injured athletes who did not undergo such testing.

# Emergency Dept Workup

- Imaging (CT, MRI) not helpful in diagnosis of concussion, but can diagnose other structural lesions.
- Not needed for most concussions
- PECARN

## Under 2 Years Old

Altered mental status  
Scalp hematoma  
Loss of Consciousness  $\geq$  5 seconds  
Severe mechanism of injury  
Palpable skull fracture  
Abnormal behavior per parent

## Between 2 and 18 Years Old

Altered mental status  
LOC  
History of vomiting  
Clinical signs of basilar skull fracture  
Severe mechanism of injury  
Severe headache

# PECARN < 2 yo

mdcalc.com

Age  <2 Years  ≥2 Years

GCS ≤14, palpable skull fracture or signs of AMS  No  Yes

AMS: Agitation, somnolence, repetitive questioning, or slow response to verbal communication

**RESULT**  
CT Recommended

Age  <2 Years  ≥2 Years

GCS ≤14, palpable skull fracture or signs of AMS  No  Yes

AMS: Agitation, somnolence, repetitive questioning, or slow response to verbal communication

Occipital, parietal or temporal scalp hematoma; history of LOC ≥5 sec; not acting normally per parent or severe mechanism of injury?  No  Yes

**RESULT**  
Observation Recommended

Age  <2 Years  ≥2 Years

GCS ≤14, palpable skull fracture or signs of AMS  No  Yes

AMS: Agitation, somnolence, repetitive questioning, or slow response to verbal communication

Occipital, parietal or temporal scalp hematoma; history of LOC ≥5 sec; not acting normally per parent or severe mechanism of injury?  No  Yes

Severe mechanism: MVC with patient ejection, death of another passenger, rollover; pedestrian or bicyclist w/o helmet struck by motorized vehicle; fall from >0.9m or 3ft; head struck by high-impact object

**RESULT**  
No Risk

# PECARN > 2 yo

mdcalc.com

Age  <2 Years  ≥2 Years

GCS ≤14 or signs of basilar skull fracture or signs of AMS  No  Yes

AMS: Agitation, somnolence, repetitive questioning, or slow response to verbal communication

**RESULT**  
CT Recommended

Age  <2 Years  ≥2 Years

GCS ≤14 or signs of basilar skull fracture or signs of AMS  No  Yes

AMS: Agitation, somnolence, repetitive questioning, or slow response to verbal communication

History of LOC or history of vomiting or severe headache or severe mechanism of injury  No  Yes

Motor vehicle crash with patient ejection, death of another passenger, or rollover; pedestrian or bicyclist without helmet struck by a motorized vehicle; falls of more than 1.5m/5ft; head struck by a high-impact object

**RESULT**  
Observation Recommended

Age  <2 Years  ≥2 Years

GCS ≤14 or signs of basilar skull fracture or signs of AMS  No  Yes

AMS: Agitation, somnolence, repetitive questioning, or slow response to verbal communication

History of LOC or history of vomiting or severe headache or severe mechanism of injury  No  Yes

Motor vehicle crash with patient ejection, death of another passenger, or rollover; pedestrian or bicyclist without helmet struck by a motorized vehicle; falls of more than 1.5m/5ft; head struck by a high-impact object

**RESULT**  
No Risk

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# So you've got a concussion, now what?

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- **CDC Heads Up 6-Step Progression**

- Step 1- Back to regular activities (such as school)
  - Step 2- Light aerobic activity
  - Step 3- Moderate activity
  - Step 4- Heavy, non-contact activity
  - Step 5- Practice and full contact
  - Step 6- Competition
- 24 hours between steps
  - Fall back if symptoms return
  - 7-day waiting period before beginning in absence of neurocognitive testing
  - This means that return to sports will take at least two weeks



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# Current Research

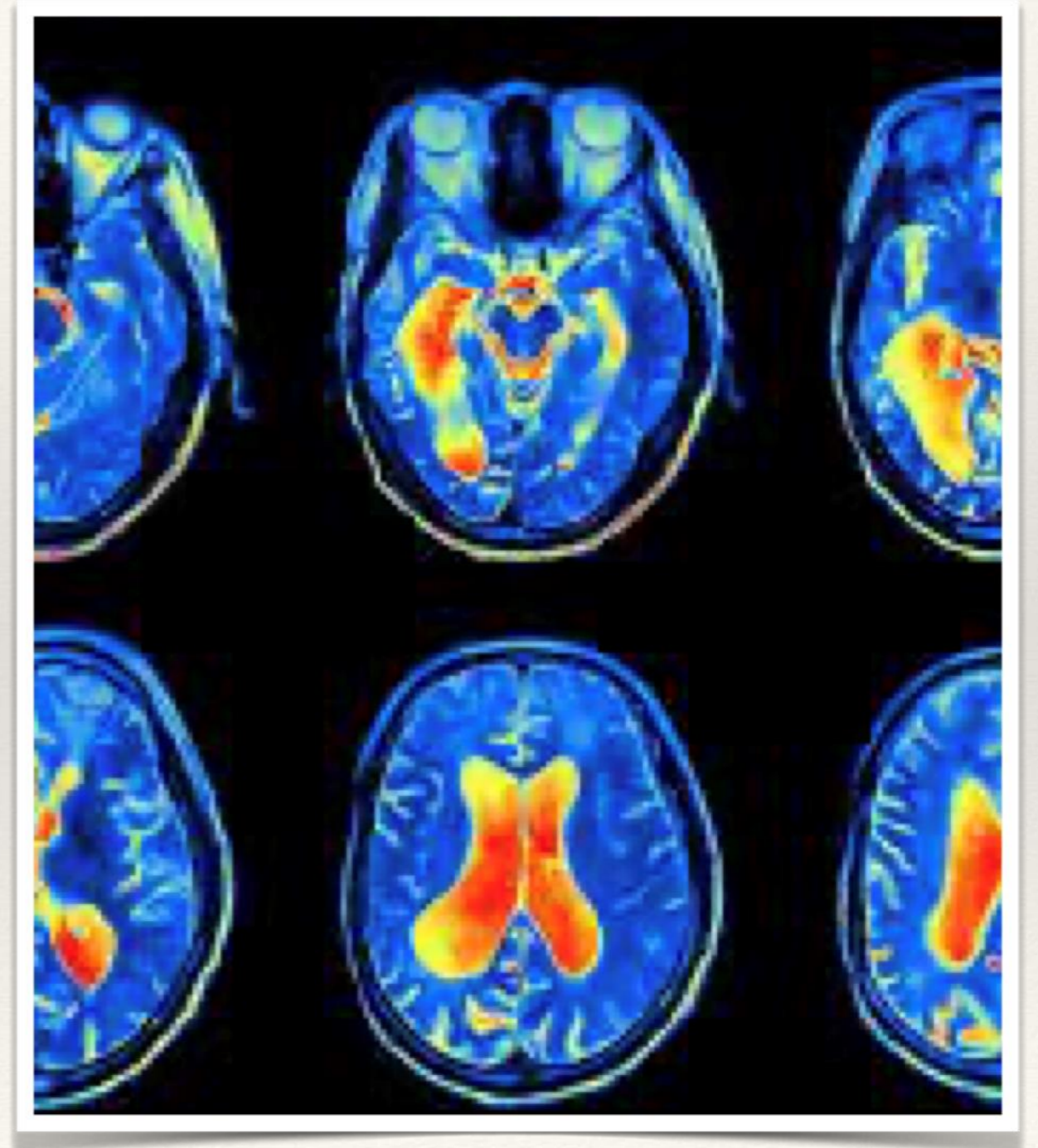
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- Biomarkers
  - Glial fibrillary acidic protein (GFAP)
  - Ubiquitin C-terminal hydrolase-L1 (UCH-L1)
  - Neuro-filament light chain
  - Tau protein



# Imaging

- fMRI (Functional MRI)
- DTI (Diffusion tensor imaging)
- MRS (Magnetic resonance spectroscopy)
- MEG (Magnetoencephalography)
- TMS (Transcranial magnetic stimulation)



# Let's end with a case...

- 20 month male falls off a 3 foot chair while father of child wasn't looking
- Head strikes the hard wood floor
- No LOC, but child fell asleep shortly after
- No vomiting
- Acting normally in the ER WR



**PECARN Pediatric Head Injury Rule** ★

**CALCULATOR**    NEXT STEPS    EVIDENCE    CREATOR

When to Use ▼    Pearls/Pitfalls ▼    Why Use ▼

*Content contributed by Daniel Runde, MD & Joshua Beiner, MD*

**Age**    **<2 Years**    ≥2 Years

**GCS ≤14, palpable skull fracture or signs of AMS**    **No**    Yes

AMS: Agitation, somnolence, repetitive questioning, or slow response to verbal communication

**Occipital, parietal or temporal scalp hematoma; history of LOC ≥5 sec; not acting normally per parent or severe mechanism of injury?**    **No**    Yes

Severe mechanism: MVC with patient ejection, death of another passenger, rollover; pedestrian or bicyclist w/o helmet struck by motorized vehicle; fall from >0.9m or 3ft; head struck by high-impact object

**RESULT**    ^

No Risk

Father and mother of child elected to observe the child at home.  
He did well. No long term issues (yet)



# Questions?

