Identifying Brain-based Biomarkers of Youth Concussion

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Concussion = mild Traumatic Brain Injury

Concussion

- is a brain injury
- results in a graded set of clinical symptoms
- symptoms reflect physiological (not structural) changes in the brain

Consensus statement, 4th International Conference on Concussion in Sport, 2012
• Millions of concussions are estimated to occur in the U.S. annually.

• For every 1 concussion in the NFL, it is estimated that there are 50,000 concussions in student-athletes. (Gerry Gioia)

• The number of children receiving care for concussion is increasing. (Bakhos et al., Pediatrics, 2010)
Common symptoms of concussion

**Physical Symptoms**
- Headaches
- Nausea
- Fatigue
- Visual problems
- Balance problems
- Sensitivity to light
- Sensitivity to noise
- Numbness/tingling
- Vomiting
- Dizziness

**Thinking Symptoms**
- Feeling mentally foggy
- Problems concentrating
- Problems remembering
- Feeling more slowed down

**Emotional Symptoms**
- Irritability
- Sadness
- Feeling more emotional
- Nervousness

**Sleep Symptoms**
- Drowsiness
- Sleeping more than usual
- Sleeping less than usual
- Trouble falling asleep

*Pre-school aged children*
- Regression in potty training
- Behavioral changes
- Nightmares
- Stomachaches

**Concussion**
Days from injury to discharge from Neurorehabilitation Concussion Clinic

ages 6-12 years

n=105

15 children reporting symptoms at discharge
• The gold standard for evaluating recovery from concussion:
  – Presence of symptoms
  – Neurological examination, including balance
  – Cognitive testing, compared to baseline, when available

• There is currently no objective measure of brain physiology in clinical use for evaluating presence of and recovery from concussion.
Behavior isn’t sufficient for assessing recovery

Jantzen et al., *Am J Neuroradiol* 2004
Resting state functional MRI

- **Dorsal Attention Network (DAN)** – supports voluntary attentional control

- **Default Mode Network (DMN)** – supports integration of cognitive and emotional processing, monitoring the world around us

- Within-network changes reported in concussion
Recovery or Compensation?

- 14 adolescents ~2 months after injury
- Many were clinically recovered and back to play at the time of research participation

Recently injured children show more connectivity between the brain’s attention and motor networks

Risen et al., *in press*
Do these eventually resolve over time?

– If so, should return to high-risk activities be based on resolution of brain findings?

– If not, is this a risk factor for
  • repeat injury
  • prolonged symptoms after next injury
  • problems later in life
A need

- Assessment tool which is:
  - Anchored to brain physiology
  - Sensitive to injury and recovery
  - Practical
  - Portable
A portable means of evaluating functional connectivity?

Sensory protocols:

- based on perception of vibrations applied to finger tips
- designed to evaluate interactions between neighboring brain regions
Understanding the brain basis of sensory findings
Recruiting for Research:

- Right-handed teenaged athletes
  - With no history of concussion
  - Within 1 week of sports-related concussion
  - 443-923-7987
He's still learning the game... hasn't even had his first concussion!
Neurorehabilitation Concussion Clinic at Kennedy Krieger Institute

• Interdisciplinary Care
  – Every child sees a brain injury physician and a neuropsychologist at every visit
  – Support as needed from Kennedy Krieger Institute’s other brain injury programs (>30+ years experience)

• Commitment to access within 1-2 weeks from parent call
  – Adding more availability as needed over time
  – East Baltimore and Columbia sites
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