Evidence-Based Management of Sports Concussion and Mild Traumatic Brain Injury: What are we Learning?

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Disclosure Statement

Micky Collins, PhD is a Co-Founder and Board Member of ImPACT Applications, a computerized neurocognitive test battery developed to assess sports concussion and Mild Traumatic Brain Injury.

Lecture Goals

- Discuss the biomechanics, pathophysiology, and neurocognitive recovery rates of sports-related mTBI.
- Discuss appropriate assessment strategies for in-office evaluation.
- Discuss risk profiles and symptom patterns that predict more protracted recoveries.
- Discuss the concept of targeted clinical pathways for the treatment and rehabilitation of sports mTBI.
Overview of Concussion

Linear Injury

Rotational Injury

Normal Neuron Function

Dendrites
Axon
Synapse
Nerve cell body
Overview of Concussion

Normal Neuron Function
Signal arrives at neuron

Normal Neuron Function
Signal travels down axon to another cell

Normal Neuron Function
Neurotransmitters are released in an organized manner, triggering the next cell with a specific coded message
Overview of Concussion

Neurometabolic Cascade Following Cerebral Concussion/MTBI

(Giza & Hovda, 2001)

Metabolic dysfunction results in ENERGY CRISIS

It may take many days for the nerve cells to return to their normal condition.

Neuron Following Concussion

After several days

(Giza & Hovda, 2001)
Overview of Concussion

Rule out more serious intracranial pathology
- CT, MRI, neurologic examination: primary diagnostic tests

Prevent against cumulative effects of injury
- Less biomechanical force causing extension of injury

Prevent presence of Post-Concussion Syndrome

Direct appropriate clinical management for return to school, return to exertion and safe return to play
- Direct targeted treatment and rehabilitation of mTBI, if indicated

Concussion Management: Areas of Focus

**Acute Management**
- Rule out more serious intracranial pathology
- CT, MRI, neurologic examination: primary diagnostic tests

**Post Injury Management**
- Prevent against cumulative effects of injury
- Less biomechanical force causing extension of injury
- Prevent presence of Post-Concussion Syndrome
- Direct appropriate clinical management for return to school, return to exertion and safe return to play
- Direct targeted treatment and rehabilitation of mTBI, if indicated

Determination of asymptomatic status essential for reducing repetitive and chronic morbidity of injury
Most Commonly Reported Symptoms

<table>
<thead>
<tr>
<th>SYMPTOM</th>
<th>PERCENT</th>
</tr>
</thead>
<tbody>
<tr>
<td># 1 Headache</td>
<td>75%</td>
</tr>
<tr>
<td># 2 Difficulty Concentrating</td>
<td>57 %</td>
</tr>
<tr>
<td># 3 Fatigue</td>
<td>52 %</td>
</tr>
<tr>
<td># 4 Drowsiness</td>
<td>51 %</td>
</tr>
<tr>
<td># 5 Dizziness</td>
<td>49 %</td>
</tr>
<tr>
<td># 6 Foggy</td>
<td>47 %</td>
</tr>
<tr>
<td># 7 Feeling Slowed Down</td>
<td>46 %</td>
</tr>
<tr>
<td># 8 Light Sensitivity</td>
<td>45 %</td>
</tr>
<tr>
<td># 9 Balance Problems</td>
<td>39 %</td>
</tr>
<tr>
<td># 10 Difficulty with Memory</td>
<td>38 %</td>
</tr>
</tbody>
</table>

Symptoms may evolve over time.

Kontos, Elbin, French Collins, AJSM, 2012; N = 1,438

Factor Analysis, Post-Concussion Symptom Scale

N=1,438
High School & University Athletes at 1-7 Days Post-Concussion

Management of Sports Concussion:
Topics of Concern

- No imaging technique or biomarker available to diagnose injury
- Lack of well controlled, prospective studies on long-term outcomes
- To date, a lack of targeted clinical and treatment pathways
- Variability in clinical management and treatment recommendations
- "Rest" does not cure all concussions
- Media hysteria driving public perception
- Self-report predating management directives.
“When it comes to concussion, don’t believe me when I tell you that I’m OK”

High School Football Player, 2014
Overview of Concussion

UPMC Clinical Evaluation
✓ Detailed Clinical Interview
✓ Vestibular-Ocular Screening
✓ Computerized Neurocognitive Testing
  • Establish diagnosis and prognosis
  • Establish clinical and treatment trajectories
  • Establish treatment and rehabilitation plan
    • Academic needs
    • Exertion level (type, duration, intensity)
    • Need for Vestibular Therapy?
    • Need for Vision Therapy?
    • Medication Management?
  • Return to play plan
Communicate Treatment Plan to Patient, Family, Referring Clinician

In-Office Evaluation
✓ Clinical Interview
✓ Vestibular-Ocular Screening
✓ Computerized Neurocognitive Testing

In-Office Evaluation
✓ Clinical Interview
✓ Vestibular-Ocular Screening
✓ Computerized Neurocognitive Testing
UPMC Vestibular/Ocular Motor Screening Form (VOMS) 5 minute exam

UPMC Vestibular/Ocular Motor Screening Form (VOMS) for Concussion

<table>
<thead>
<tr>
<th>Vestibular/Ocular Motor Test</th>
<th>Concussed</th>
<th>Controls</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEASUREMENT SYMPTOMS</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Smooth Pursuits</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saccades - Horizontal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saccades - Vertical</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smooth Pursuits Horizontal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VOR - Horizontal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VOR - Vertical</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual Motion Sensitivity</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Symptoms Reported By Patient on 0-10 Point Scale

Concussed patients (n=85) score higher on ALL VOMS items* than controls (n=85).

* p<0.001

The Diagnostic Accuracy of the VOMS (adj. for age) for Predicting Concussed Patients is Excellent (.90 [95% CI=.86-.95], p<.001).

VOMS Items=.90

Receiver Operating Characteristic Curve

Dotted line=.50 or no better than chance

Positive Prediction Rate of 90%

In-Office Evaluation

- Clinical Interview
- Vestibular-Ocular Screening
- Computerized Neurocognitive Testing

Immediate Post-Concussion Assessment and Cognitive Testing-ImPACT
Computerized Neurocognitive Testing

Mark Lovell, PhD, FACP, Dsc.
Software Developer, ImPACT

Micky Collins, PhD - UPMC
Department of Orthopaedic Surgery
Program Director-UPMC Sports Concussion Program

Joseph Maroon, MD – UPMC
Department of Neurological Surgery
Team Physician-Pittsburgh Steelers
**Overview of Concussion**

**ImPACT: Post-Concussion Evaluation**
- 20-25 Minute, On-Line Office-Based Tool
- Concussion Symptom Scale
  - 21 Item Likert Scale (e.g. headache, dizziness, nausea, etc)
- 8 Neurocognitive Measures
  - Verbal Memory, Visual Memory, Reaction Time, Processing Speed Summary Scores
- Detailed Clinical Report
  - Outlines Demographic, Symptom, Neurocognitive Data
- Internal baseline validity checks built into program (demarcates poor effort)
- On-Line Version Available
  - Extensive normative data available from ages 11-60
- Over 175 peer-reviewed research articles published since 2000
  - Extensive data published on reliability, validity, sensitivity/specificity, added value, and prognostic ability of test

**Concussion Evaluation Timeline**

*Computerized Neurocognitive Testing and Clinical Evaluation*

**Pre-season**
- Baseline testing
  - Supervised by ATC, PT, Physician, Clinic, or School

**1-3 Days**
- Concussion First follow-Up
  - Sideline Evaluation: Are symptoms of concussion present? RTP for remainder of season?
  - Emergency Room Visit?
  - Are there intracranial concerns?

- Specialty Clinic Evaluation: Clinical management decisions determined

**Follow-up Evaluation as needed**
- Return to play

**Does Computerized Neurocognitive Testing Work?**
Examining Sensitivity/Specificity of testing
Two Athlete Groups Examined

Study 1 (Concussed symptomatic athletes)

- 162 athletes
- 81 concussed athletes (diagnosed by ATC/Physician)
- 81 carefully matched controls (non-concussed) matched on specific basis of gender, sport, concussion history, absence of LD/ADD
- Discriminate Function Analysis on subscale scores; no clinician input
- Testing completed within 3 days post injury
- Sensitivity/Specificity of neurocognitive testing determined

Study 2 (Asymptomatic concussed athletes)

- 74 athletes
- 37 athletes diagnosed with on-field concussion by ATC/physician, seen within 3 days of injury, and symptom score of 0
- 37 carefully matched controls (non-concussed) matched on specific basis of gender, sport, concussion history, absence of LD/ADD
- Discriminate Function Analysis on Subscale scores; no clinician input
- Testing completed within 3 days post injury
- Sensitivity/Specificity of Computerized Neurocognitive Testing determined
Overview of Concussion

Sensitivity and Specificity of Computerized Neurocognitive Testing

Schatz et Sandel N. Sensitivity and Specificity of the online version of ImPACT in high school and collegiate athletes. American Journal of Sports Medicine, 2013.

Study 2 (Asymptomatic concussed athletes)

Sensitivity (94.6%) (Probability that that a concussion is present when test is positive)

Specificity (97.3%) (Probability that a concussion is not present when test is negative)

Measuring Neurocognitive Recovery from Sports mTBI

How Long Does it Take?

<table>
<thead>
<tr>
<th>Authors</th>
<th>Sample Size</th>
<th>Age</th>
<th>Population</th>
<th>Tests Utilized</th>
<th>Days Cognitive</th>
<th>Days Symptom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lovell et al. 2005</td>
<td>95</td>
<td>Pro (NFL)</td>
<td>Paper and Pencil</td>
<td>1 day</td>
<td>1 day</td>
<td></td>
</tr>
<tr>
<td>McCrea et al. 2003</td>
<td>94</td>
<td>College</td>
<td>SAC</td>
<td>&lt;1 Day</td>
<td>7 days</td>
<td></td>
</tr>
<tr>
<td>McCrea et al. 2003</td>
<td>94</td>
<td>College</td>
<td>Paper and Pencil</td>
<td>5-7 days</td>
<td>7 days</td>
<td></td>
</tr>
<tr>
<td>Echemendia 2001</td>
<td>29</td>
<td>College</td>
<td>Paper and Pencil</td>
<td>3-5 days</td>
<td>3 days</td>
<td></td>
</tr>
<tr>
<td>Guskiewicz et al. 2003</td>
<td>94</td>
<td>College</td>
<td>Balance</td>
<td>3-5 Days</td>
<td>7 Days</td>
<td></td>
</tr>
<tr>
<td>Bleiberg et al. 2005</td>
<td>64</td>
<td>College</td>
<td>Computer</td>
<td>3-7 days</td>
<td>Did Not Evaluate</td>
<td></td>
</tr>
<tr>
<td>Iverson et al. 2006</td>
<td>30</td>
<td>High School</td>
<td>Computer</td>
<td>10 days</td>
<td>7 Days</td>
<td></td>
</tr>
<tr>
<td>McDonald et al. 2005</td>
<td>105</td>
<td>High School</td>
<td>Computer</td>
<td>36 days</td>
<td>5-10 Days</td>
<td></td>
</tr>
<tr>
<td>Lovell, Collins et al. 2008</td>
<td>208</td>
<td>High School</td>
<td>Computer</td>
<td>26 days</td>
<td>17 Days</td>
<td></td>
</tr>
<tr>
<td>Covassin et al. 2011</td>
<td>72</td>
<td>Ages 11-15</td>
<td>Computer</td>
<td>21 days</td>
<td>7 Days</td>
<td></td>
</tr>
<tr>
<td>Maugans et al. 2012</td>
<td>12</td>
<td>Ages 11-15</td>
<td>Computer</td>
<td>30 days</td>
<td>14 Days</td>
<td></td>
</tr>
</tbody>
</table>
Overview of Concussion

Individual Recovery From High School Football-Related Concussion: How Long Does it Take?

Prognosticating Complicated Concussion Outcomes: An Evidence-Based Analysis

Which On-Field Symptoms Predict Protracted Recovery (> 3 weeks of recovery time)


5th Annual Current Concepts in Brain Injury Rehabilitation
November 1-2, 2014
Overview of Concussion

5th Annual Current Concepts in Brain Injury Rehabilitation
November 1-2, 2014

• 176 male high school and college football players
• Athletes had baseline neurocognitive testing and were revaluated within three days of injury.
  • All followed until clinical recovery
    - Within RCI of baseline on ImPACT for neurocognitive/symptom scores
• 32% of sample required < 7 days until recovery (N = 56) “Rapid Recovery” (Mean =4.9 days)
• 17% of sample required > 21 Days until recovery (N=31) “Protracted Recovery” (Mean =33.2 days)
• 39% of sample required 7-14 days until recovery (N = 68)

Which On-Field Symptoms Predict Protracted Recovery Time?

Methodology

• 12% lost to follow up (e.g. did not RTP or no follow-up in clinic) (N = 21)
• MANOVA used to determine differences between rapid/> 3 week recovery
• ATC’s documented on-field markers (e.g. LOC, Confusion, Amnesia) and on-field Symptoms (e.g. headache, dizziness, balance, photosensitivity, etc.)

Which On-Field Symptoms Increase Risk of Post Concussion Syndrome in Football Players? (Continued)

Which On-Field Markers/Symptoms Predict 3 or More Week Recovery from MTBI In High School Football Players

<table>
<thead>
<tr>
<th>On-Field Marker</th>
<th>N</th>
<th>Chi²</th>
<th>P</th>
<th>Odds Ratio</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posttraumatic Amnesia</td>
<td>92</td>
<td>1.29</td>
<td>0.267</td>
<td>1.711</td>
<td>0.64-4.62</td>
</tr>
<tr>
<td>Retrograde Amnesia</td>
<td>97</td>
<td>1.23</td>
<td>0.229</td>
<td>1.179</td>
<td>0.56-2.10</td>
</tr>
<tr>
<td>Confusion</td>
<td>98</td>
<td>1.14</td>
<td>0.286</td>
<td>1.564</td>
<td>0.98-2.42</td>
</tr>
<tr>
<td>LOC</td>
<td>95</td>
<td>2.74</td>
<td>0.100</td>
<td>0.806</td>
<td>0.39-1.67</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>On-Field Symptom</th>
<th>N</th>
<th>Chi²</th>
<th>P</th>
<th>Odds Ratio</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dizziness**</td>
<td>98</td>
<td>6.97</td>
<td>0.006</td>
<td>6.422</td>
<td>1.18-29.7</td>
</tr>
<tr>
<td>Headache</td>
<td>98</td>
<td>0.64</td>
<td>0.423</td>
<td>2.421</td>
<td>0.26-22.6</td>
</tr>
<tr>
<td>Sensitivity/Disuse</td>
<td>98</td>
<td>1.30</td>
<td>0.254</td>
<td>1.880</td>
<td>0.79-4.43</td>
</tr>
<tr>
<td>Visual Problems</td>
<td>97</td>
<td>0.61</td>
<td>0.434</td>
<td>1.605</td>
<td>0.63-4.22</td>
</tr>
<tr>
<td>Fatigue</td>
<td>97</td>
<td>0.66</td>
<td>0.418</td>
<td>1.880</td>
<td>0.68-4.37</td>
</tr>
<tr>
<td>Balance Problems</td>
<td>98</td>
<td>0.29</td>
<td>0.591</td>
<td>0.603</td>
<td>0.30-1.18</td>
</tr>
<tr>
<td>Personality Change</td>
<td>8</td>
<td>0.06</td>
<td>0.806</td>
<td>1.000</td>
<td>0.07-10.86</td>
</tr>
<tr>
<td>Hearing</td>
<td>97</td>
<td>0.66</td>
<td>0.434</td>
<td>1.605</td>
<td>0.63-4.22</td>
</tr>
</tbody>
</table>

The total sample was 107. Due to the normal difficulties with collecting on-field markers, there were varying degrees of missing data. The number of subjects who had each coded ranged from 92-98. The N column represents the number of subjects for whom data were available for each category. Markers of injury are not mutually exclusive.

* p<.01


Lau, Kontos, Collins, AJSM 2011
Which Symptoms at 3 Days Post Injury Best Predict Protracted Recovery?

Lau B, Lovell MR, Collins MW; Pardini J; CISM 2009 (3):216-21

Current Symptoms

- Headache
- Nausea
- Tinnitus
- Balance Problems
- Dizziness
- Fingernails
- Numbness
- Depression
- Trouble falling asleep
- Feeling more fatigued
- Sleeping more than usual
- Difficulty sleeping
- Sudden change in sleep
- Feeling less alert
- Fatigue
- Trouble concentrating
- Difficulty remembering
- Feeling slowed down
- Feeling mentally foggy
- Difficulty concentrating
- Difficulty remembering
- Visual problems (blurry or double vision)

Expressed as Effect Sizes (Cohen’s D). Only includes symptoms with large (greater than .80) effect sizes. Sample is composed of 108 male high school football athletes.

Lau, Lovell, Collins et al. 2009, CISM

Top 11 Symptom Predictors of Protracted Recovery

- FOGGY
- DIZZY
- SLOWNESS
- NOISE SENS
- DIZZY-CONGAUS
- BOREAL
- BALANCE
- NARINESS
- VOMIT
- HEADACHE
- LIGHT SENS

Expressed as Effect Sizes (Cohen’s D). Only includes symptoms with large (greater than .80) effect sizes. Sample is composed of 108 male high school football athletes.

Lau, Lovell, Collins et al. 2009, CISM
Determination of ImPACT Cutoff Scores that Predict 3 or more weeks of recovery


<table>
<thead>
<tr>
<th>Neurocognitive Domain</th>
<th>75% Sensitivity</th>
<th>80% Sensitivity</th>
<th>85% Sensitivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verbal Memory</td>
<td>66.5</td>
<td>64.5</td>
<td>60.5</td>
</tr>
<tr>
<td>Visual Memory</td>
<td>48</td>
<td>46</td>
<td>44.5</td>
</tr>
<tr>
<td>Processing Speed</td>
<td>24.5</td>
<td>23.5</td>
<td>22.5</td>
</tr>
<tr>
<td>Reaction Time</td>
<td>0.72</td>
<td>0.78</td>
<td>0.86</td>
</tr>
</tbody>
</table>

Sensitivity is defined as the ability of the cutoff to accurately identify protracted recovery (8 weeks or more) on an athlete.

Case Example: NFL Defensive Back

Clinical Report

<table>
<thead>
<tr>
<th>Test Type</th>
<th>Baseline</th>
<th>Post Injury 1</th>
<th>Post Injury 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date Tested</td>
<td>06/16/2012</td>
<td>09/17/2012</td>
<td>09/17/2012</td>
</tr>
<tr>
<td>Language</td>
<td>English</td>
<td>English</td>
<td>English</td>
</tr>
<tr>
<td>Test Version</td>
<td>2.1</td>
<td>2.1</td>
<td>2.1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Composite Score</th>
<th>Percentile scores if available are listed in small type.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memory composite (total)</td>
<td>70% 80% 90% 100% 11%</td>
</tr>
<tr>
<td>Memory composite (total)</td>
<td>70% 80% 90% 100% 11%</td>
</tr>
<tr>
<td>Visual motor speed composite</td>
<td>20.45 35% 25.20 28.00 14%</td>
</tr>
<tr>
<td>Reaction time composite</td>
<td>3.64 9% 3.64 9% 3.64 9%</td>
</tr>
</tbody>
</table>
| Impulse control composite | 1.5 51%
| Total SPM Score | 3 98 |

Overview of Concussion

Established (?) Constitutional Risk Factors For More Complicated Recovery Following Concussion

<table>
<thead>
<tr>
<th>Younger Age</th>
<th>Field, Lovell, Collins et al, J of Pediatrics, 2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning Disability</td>
<td>Collins, Lovell et al, Jama, 1999</td>
</tr>
<tr>
<td>Repetitive Concussion</td>
<td>Collins, Lovell et al, Neurosurgery, 2004</td>
</tr>
<tr>
<td>Female Gender</td>
<td>Cohen, Lovell, Pardini, Mullin, Collins, JAMA, 2009</td>
</tr>
</tbody>
</table>

Outcomes are highly variable

- Vestibular-related symptoms (dizziness/fogginess) and migraine history/symptoms best predict protracted recoveries
- Effective acute assessment/management and referral key
- Return to play prior to full recovery from concussion will result in worse outcome and less force causing re-injury.
- Neurocognitive testing is an effective tool to help quantify the injury and guide the management and RTP process.
- The “mild” injuries may become complicated and the “severe” injuries may become mild
- Proper Clinical management is best form of prevention
- Targeted clinical pathways for treatment and rehabilitation are being established

Concussion Clinical Trajectories: A Model for Understanding Assessment, Treatment and Rehabilitation

Clinical Trajectories Determined by:
- Clinical Interview
  - Constitutional risk factors
  - Symptom clusters
  - What questions to ask?
- Vestibular-Ocular Screening
  - Provocative or not?
- Specific findings help determine level/type of exertional activity
- Computerized Neurocognitive Testing
  - Specific cognitive profiles for specific clinical trajectories

Findings lead to individually determined treatment and rehabilitation plan


What We Know

- Outcome variability
- Vestibular-related symptoms (dizziness/fogginess) and migraine history/symptoms predict prolonged recoveries
- Effective acute assessment, management, and referral key
- Return to play prior to full recovery from concussion results in worse outcome and less force causing re-injury
- Neurocognitive testing is an effective tool to help quantify the injury and guide the management and RTP process
- The “mild” injuries may become complicated, and the “severe” injuries may become mild
- Proper clinical management is the best form of prevention
- Targeted clinical pathways for treatment and rehabilitation are being established
Overview of Concussion

Using Concussion Clinical Trajectories to Inform Targeted Treatment Pathways

Pre-Existing Risk Factors
- Previous Concussions
- Migraine
- LD/ADHD
- Female Gender
- Age
- Motion sensitivity, Visual Disturbance

Concussion Clinical Trajectories

Treatment and Rehab Pathways
- Vestibular
- Ocular
- Cognitive
- Anxiety/Mood
- Cervical

Extensive Data Published on Risk Factors

UPMC Concussion Program

Emergency Departments
- Pediatric Practices
- Certified Athletes Trainers
- Primary Care Physicians

Further Assessment and Treatment If Indicated

Research: Next Steps

Clinical Trajectories Derived by:
- Clinical Interview
- Vestibular-Ocular Screening
- Computerized Neurocognitive Testing
- Neuroimaging

Purpose: To corroborate functional impairment with corresponding changes in the brain and to inform better assessment and treatment pathways

UPMC Sports Medicine Concussion Program

Over 20,000 patient visits annually

UPMC Concussion Program

Referral Sources
- Emergency Departments
- Pediatric Practices
- Certified Athletes Trainers
- Primary Care Physicians
- Orthopaedic/Neuro-Surgery
- Neuro Radiology
- Vestibular/Physical Therapy
- PM & R
- Behavioral Neuro-Optometry
- Primary Care Sports Med

Further Assessment and Treatment If Indicated

5th Annual Current Concepts in Brain Injury Rehabilitation
November 1-2, 2014
Efficacy of High Definition Fiber Tracking (HDTFT) to identify and inform Safe Return to Play from Concussion - NFL/GE Head Health Challenge

- NFL/GE grant award to the University of Pittsburgh
- Combines comprehensive clinical, functional, and imaging assessments among:
  - 50 athletes aged 13-28 yrs with a sport-related concussion
- 1-7 day clinical, functional and HDTFT imaging assessments with follow-up testing at date of "medical clearance"

Kontos, Collins, Schneider - co-PIs

Targeted Evaluation, Action and Monitoring of Traumatic Brain Injury (TEAM TBI) - Dept of Defense

- $4.3M, 2-yr project with the University of Pittsburgh, National Intrepid Center of Excellence (NICoE), and Naval Medical Center San Diego (NMCSO)
- Combines comprehensive clinical, functional, and imaging assessments with targeted treatment pathways among:
  - 120 military personnel with chronic (3+ months) mTBI
- Pre-treatment and ~3 month post-treatment clinical, functional and imaging follow-up evaluations

Okonkwo, Schneider, Kontos, Collins - co-PIs

Replication of the UPMC Sports Medicine Concussion Program

Referral Sources

Pediatric Practices
Certified Athletic Trainers
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