MILD TRAUMATIC BRAIN INJURY & POST-CONCUSSION SYMPTOMS

Mel B. Glenn, MD
Spaulding Rehabilitation Hospital
Harvard Medical School
NeuroRestorative
Community Rehab Care
DISCLOSURES

- My wife has a psychotherapy private practice.
DEFINITION: MILD TBI (CONCUSSION)

- External force with perturbation of brain
  - Loss of memory for before or after trauma
  - Or, < 30” LOC or other mental status change (including being ‘dazed’) or other neurologic sequelae
  - And, after 30”: GCS score 13-15
  - And, PTA <24 hrs

(mTBI Committee, HI-ISIG, ACRM, 1993)

*If intracranial findings on day of injury CT, then “complicated mild”

(Williams, 1990)
MOST COMMON POST-CONCUSSIVE SYMPTOMS

- Headaches
- Dizziness
- Fatigue or sleepiness
- Forgetfulness
- Inattention
- Slow processing
- Irritability
- Insomnia
- Depression
- Anxiety
- Nausea & vomiting
- Sensitivity to light & noise
PERSISTENT POST-CONCUSSIVE SYMPTOMS

- Continue >3 months
- Sports concussions: 1-3% have PPCS
- Concussions of all etiologies: <5% up to 31% > controls
CONTROVERSY OVER LONG-TERM COGNITIVE IMPAIRMENT & PCS AFTER MILD TBI

The black & white perspective:
1: It’s all in their heads.
OR
2: It’s caused by brain injury.
PCS-LIKE SYMPTOMS IN COMMUNITY CONTROLS
(Yellow = Mild Symptoms; Red = Mod-Severe)

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Yellow</th>
<th>Red</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headaches</td>
<td>52</td>
<td>3</td>
</tr>
<tr>
<td>Fatigue</td>
<td>76</td>
<td>14</td>
</tr>
<tr>
<td>Noise Sensitivity</td>
<td>40</td>
<td>3</td>
</tr>
<tr>
<td>Concentration</td>
<td>61</td>
<td>16</td>
</tr>
<tr>
<td>Memory</td>
<td>51</td>
<td>14</td>
</tr>
</tbody>
</table>
PCS-LIKE SYMPTOMS IN COMMUNITY CONTROLS

DSM-IV diagnosis of postconcussion disorder 79.6%

Moderate-severe symptom endorsement 14.6%
## POST-CONCUSSIVE SYMPTOMS
### 3-4 MONTHS POST-IRAQ DEPLOYMENT

<table>
<thead>
<tr>
<th>Symptom</th>
<th>w LOC</th>
<th>w MS Δ</th>
<th>Other injury</th>
<th>No injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache</td>
<td>32%</td>
<td>18%</td>
<td>12%</td>
<td>8%</td>
</tr>
<tr>
<td>Dizziness</td>
<td>8%</td>
<td>6%</td>
<td>3%</td>
<td>2%</td>
</tr>
<tr>
<td>Fatigue</td>
<td>53%</td>
<td>40%</td>
<td>35%</td>
<td>20%</td>
</tr>
<tr>
<td>Sleep Problem</td>
<td>54%</td>
<td>45%</td>
<td>37%</td>
<td>24%</td>
</tr>
<tr>
<td>Memory</td>
<td>25%</td>
<td>16%</td>
<td>14%</td>
<td>7%</td>
</tr>
<tr>
<td>Concentration</td>
<td>31%</td>
<td>26%</td>
<td>18%</td>
<td>10%</td>
</tr>
</tbody>
</table>

*(Hoge et al, 2008)*
OTHER CONDITIONS WITH “POST-CONCUSSIVE SYMPTOMS”

- Common in
  - Depression & anxiety, including PTSD & acute stress
  - Whiplash injuries
  - Fibromyalgia
  - Non-head injuries
  - People litigating non-head injuries
  - General population
NON-BRAIN INJURY CAUSES
OF SPECIFIC POST-CONCUSSIVE SYMPTOMS

- **Headache**: neck pain, soft tissue injury, occipital neuralgia, vascular changes (migraine), difficulty concentrating, insomnia, sleep apnea, psychological stresses, medications, etc.
- **Dizziness**: vestibular injury, neck pain, psychological stresses, medications, etc.
- **Insomnia**: anxiety, depression, sleep disorders, medications, etc.
CAUSES OF COGNITIVE IMPAIRMENT & FATIGUE

- Brain injury
- Insomnia
- Pain, e.g., headache
- Stress, depression, & anxiety (including PTSD)
  (Diaz-Ferreira et al, 2009)
- Medications
- Vicious cycle can develop with above!

(Continued next slide)
CAUSES OF COGNITIVE IMPAIRMENT & FATIGUE

- Sleep apnea & other sleep disorders
- Aging
- Neuroendocrine disorders
  - Incidence 16.8% in mTBI (Schneider et al., 2007; Tanriverdi et al., 2010)
- Other medical illness
- ADHD & learning disability
- Expectation (“diagnosis threat”) (Suhr & Gunstad, 2002; 2005)
- Misattribution
- Secondary gain (spectrum: somatoform disorders to malingering)

- NP testing usually cannot distinguish brain injury from other causes
Typical Course of Mild TBI
SPORTS CONCUSSIONS

- Many studies test before & after
- Recovery to pre-injury cognition within days or weeks
- Most studies done with young subjects

(E.G., McCrea et al. 2003; Pellman et al, 2006; Collins et al, 2006; Dikmen et al, 1995)
PENNSYLVANIA HIGH SCHOOL FOOTBALL PLAYERS

- 2,141 players
- 134 concussions
- Players tested until recovered

(Collins et al 2006)
RECOVERY CURVE
(N = 134)
RECOVERY CURVES
(N = 134)

No Previous Concussions

1 or More Previous Concussions
META-ANALYSIS

- Cognitive recovery from mild TBI is complete within 3 months*
  (Schretlan DJ, et al, 2003; Rohling et al, 2011)

*Studies of people with “complicated mild” TBI show differences from controls & other mTBI (Williams, 1990: Kashluba et al, 2008)
PREDICTORS OF PCS AFTER MILD TBI

- 2 Groups
  - Mild TBI
  - Orthopedic injuries

- Predictors of PCS at 3 months post
  - pre-injury psychiatric history
  - pre-injury physical health
  - Having had mTBI and cognitive test scores did **not** predict PCS

(Ponsford et al, 2012)
COGNITIVE IMPAIRMENT: 
SYMPTOM AUGMENTATION (EXAGGERATION)

- **Forensic Military Population:**
  - 59% of mTBI failed effort testing
  - Testing worse than severe TBI associated with failure of effort testing 
    (Lange et al, 2012; Rohlings et al, 2010; Larson, 2013)

- **Civilian Worker’s Compensation Population:**
  - 26.7% of mTBI failed Test of Memory Malingering (TOMM)
  - Higher rate in those with better compensation
    - Moderate-severe TBI had similar rates
    - *So failure does not exclude impairment related to TBI*
    (Bianchini et al, 2006)

- **Malingering:** Difficult to be certain unless effort testing is positive
  - But the presence of malingering does not R/O TBI as *part* of cause
INDICATORS THAT POSSIBLE NON-BRAIN INJURY FACTORS ARE INVOLVED

- Persistence of symptoms in those with mildest injuries (e.g., “dazed”) or no concussion
- Worse than severe TBI on testing
- Testing not compatible with level of function
- Little or no improvement in cognitive status over time
HOWEVER, THERE IS ANOTHER SIDE TO THE STORY
THOSE WITH PERSISTENT BRAIN DYSFUNCTION MAY BE OUTLIERS

- Small # impaired can be obscured in studies & meta-analyses
- Larger studies needed (many 1,000’s)

(Iverson, 2010; Glenn, 2014)
NON-PSYCHOSOCIAL PREDICTORS OF PCS

- Predictors of PCS at 3 mos after mTBI & “complicated” mTBI
  - pre-injury psychiatric history
  - age
  - lower education

- Predictors of PCS at 6 mos after mTBI & “complicated” mTBI
  - Above plus GCS score, injury caused by assault, & extracranial injury
    (Lingsma et al, 2014)
AGE & MTBI

- Association of lasting cognitive impairment with older age
  (Mazzucci et al, 1992; Papa et al, 2012; Lingsma et al, 2014)

- Some studies show no such association
  (Goldstein et al, 2001; Mickeviciene et al, 2004; Yuh et al, 2014)
SUBTLE CHANGES AFTER MILD TBI

- Differences on more difficult cognitive tests at $\geq 3$ mos compared to controls (Bleiburg et al, 1998; Vanderploeg et al, 2005; Malojcic, 2008; Pare et al, 2009)
- Balance & gait impaired during cognitive tasks years after mTBI (Broglio, 2012)
SPORTS: LONG-TERM RESIDUA OF MULTIPLE CONCUSSIONS

- NP testing worse than controls
  - Suggests at least subclinical residua
    - $0 + 0 + 0 = 0$
    - $1 + 1 + 1 = 3$
- NP testing worse with multiple concussions & h/o learning disability
- However baseline testing not obtained: those with more impairment pre-injury may have more concussions

(Roberts, 1975; Collins et al, 1999; Matser et al, 1999; Guskiewicz et al, 2005; Iverson et al, 2006; Belanger et al, 2010; Lehman, 2012)
CHRONIC TRAUMATIC ENCEPHALOPATHY

- 85 boxers, football & hockey players, & military veterans with multiple concussions*
  - Most had cognitive impairment or dementia
  - Some had Parkinsonian features
  - Some had depression, suicidality, aggression
  - 68 had pathologic findings of CTE (see next slide)
    - 43 CTE alone
    - Others with MND, AD, FTD, Lewy body disease
    - Symptoms usually began 8-10 years after retired
    - 1 asymptomatic, 2 dx’d with PTSD only
      (Mckee et al, 2009, 2012)

*+1 person with repetitive head-banging
PATHOLOGY

- Chronic traumatic encephalopathy
  - Cerebral atrophy
  - **Tau** immunoreactive inclusions
    - Neurofibrillary tangles
    - Glial tangles
    - Neuropil neurites
    - Different distribution than in AD
  - Some cases: beta-amyloid
  - Some cases: TDP-43 proteinopathy
  - Cavum septi pellucidi with fenestrations
  - Shrinkage of the mammillary body

(McKee et al, 2009; McKee et al, 2012; Gavett et al, 2011)
CHRONIC TRAUMATIC ENCEPHALOPATHY

- Mckee et al studies
  - Not population based, so we do not know incidence
  - Few controls (e.g., perhaps many asymptomatic players have these findings)
  - No baseline assessment
EVIDENCE FROM BIOMARKERS SUGGESTIVE OF LONG-STANDING BRAIN INJURY

- Functional MRI (fMRI) (McAllister et al, 2006; Mayer, 2011)
- Event-related potentials (Lachapelle et al, 2008; Broglio, 2012)
- Magnetic resonance spectroscopy (MRS)
- Single positron emission CT (SPECT)
- Positron emission tomography (PET)
- Magnetic source imaging (MEG + MRI)
- Serum protein S-100B (Stalnacke et al, 2005; Shahim et al, 2014)
ETIOLOGY OF LONG-TERM COGNITIVE RESIDUA OF MTBI?

MY OPINION: THERE IS A SPECTRUM

1. Persistent significant brain injury: More extensive mTBI than is typical
2. Persistent brain injury, often minor, with one or more of the following:
   - Prior concussion(s)
   - Numerous subconcussive blows
   - Previous learning disability
   - APOE ε-4 genotype
   - Older age
   - Pre-injury psychological susceptibility
   - Anxiety &/or depression (pre-existing or related to PCS—see later slide)

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ETIOLOGY OF LONG-TERM COGNITIVE RESIDUA OF MTBI?

(continued)

- PTSD related to circumstances surrounding injury
- Stressful social-vocational circumstances
- Sleep disorders: insomnia, sleep apnea, others
- Chronic headaches or other pain
- Secondary financial gain

- 3. Impairment due to TBI resolved, but 1 or more of above factors persist
- 4. Never actually had a TBI, but has one or more of above
EVIDENCE FOR MULTIFACTORIAL ETIOLOGY OF PCS

- Regression analyses: predictors of worse 6-month RPQ-13 scores after mTBI
  - age (p=.02)
  - trend for neuropsychiatric history (p=0.07)
  - trend for axonal disruption in at least one area on DTI at 3 weeks (p=.07)  
    (Yuh et al, 2014)

The best approach to mTBI is a “complex biopsychosocial model”.

(Iverson)
IT CAN BE EXTREMELY STRESSFUL TO HAVE A MILD TBI WITH COGNITIVE &/OR PHYSICAL SYMPTOMS
POST-CONCUSSION SYMPTOMS: MANAGEMENT

• Early
  • No return to sports, school, or work that day
  • Out of sports, school, or work until symptom-free or reduced
  • No driving for at least 24 hours, longer depending on symptoms
  • Take it easy (short walks, visiting with friends, TV) for “a while”
    • Children with shorter rest time took longer to recover
      (Brown et al, 2014)
  • Gradual return to activity; graded exercise for athletes
  • Educate, reassure within reason
  • Validate stress & anxiety
  • Explain & anticipate-stress can worsen symptoms
    (Harmon et al, 2013; Silverberg & Iverson, 2013; Ontario Neurotrauma Foundation, 2010; McRory, 2009)
POST-CONCUSSION SYMPTOMS: MANAGEMENT

- Late: treat symptomatically
  - “Easier” to treat & underlying symptoms 1\textsuperscript{st} (e.g., OSA, endocrine, insomnia, depression)
  - Cognitive later (OT, Speech Therapy)
    - Rehabilitation: Emphasize endurance, attention, processing speed
    - Medications (Chew & Zafonte, 2009)
  - Psychotherapy usually indicated: See next slide

(Ontario Neurotrauma Foundation, 2010)
PSYCHOLOGICAL SYMPTOMS: TREATMENT

- **Psychotherapy**
  - Cognitive behavior therapy: targets thought process, reframing
  - Acceptance and commitment therapy (ACT): targets acceptance, mindfulness, values
  - Self-management: targets self-efficacy, acceptance
    (Iverson et al, Ch. 30 in Zasler, Katz, Zafonte, 2013)
  - Eye movement desensitization and reprocessing (for PTSD)
  - Exposure therapy (for PTSD)

- **Medications for depression & anxiety**
  - Start with SSRI’s in most cases
  - Prazosin for post-traumatic nightmares (Berardis et al, 2015)
    (Ontario Neurotrauma Foundation, 2010)
POST-CONCUSSION SYMPTOMS: MANAGEMENT

- Late: Global treatment approaches
- Global treatments
  - Exercise below heart rate causing symptoms (Leddy et al, 2010)
  - Self-management therapy
    - Have patient set functional goals (e.g., I will have dinner with my family 3x/week)
    - Return next week to discuss progress and barriers
      (Iverson, Personal Communication, 2014)
POST-CONCUSSION SYMPTOMS: MANAGEMENT

- Alternative Medicine Treatments
  - Acupuncture, Acupressure (Mcfadden et al, 2011)
  - Emotional Freedom Techniques ("tapping") (Gilomen & Lee, 2015)
  - Homeopathy (Chapman et al, 1999)
  - Mindfulness Meditation (Johansson et al, 2012)
  - Integrative Restoration Yoga Nidra (Stankovic, 2011; Pence et al, 2014)
SUMMARY

- mTBI may leave persistent PCS in some
- Approach as a “complex biopsychosocial” phenomenon
- Other factors may contribute to persistent cognitive impairment
  - Previous concussions
  - Learning disability or ADD
  - Psychological factors
  - Social/vocational factors
  - Pain
  - Sleep disorders
  - Age
  - Secondary gain

- Treatment of PCS
  - Education
  - Treat symptomatically
  - Psychotherapy: CBT, ACT, self-management, supportive/insight
  - Aerobic exercise
THANK YOU!