Neuropsychological Management after Pediatric Mild TBI

Michael W. Kirkwood, PhD, ABPP/CN

Children’s Hospital Colorado

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Children’s Hospital Colorado
Concussion Team Collaborators
• David Baker, PsyD
• Jerry Clayton, PhD
• Amy Connery, PsyD, ABPP/CN
• Katherine Dabah, MD
• Mike Dichiaro, MD
• Joe Grubenhoff, MD
• Mike Handler, MD
• Todd Hankinson, MD
• Scott Lakier, MD
• Jackie Murray, RN
• Brent O’Neill, MD
• Robin Peterson, PhD
• Wendy Pierce, MD
• Aaron Provance, MD
• Anne Stratton, MD
• Pam Wilson, MD
• Bridget Younger, MEd, ATC

Student Collaborators
• Robert Blaha, MA
• Cassie Green, MA
• David Hargrave, MA
• Christa Hutaff-Lee, PhD
• Jennifer Larson, PhD

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Neuropsychological Outcomes: Initial research

- Mild TBI / concussion largely neglected historically as a topic of scientific study
- Neurobehavioral outcome work in children did not begin in earnest until late 1970s and 1980s
- Several reviews summarized initial work and suggested that mild TBI apt to lead to significant cognitive, academic, and psychosocial problems for many children
  - Boll (1983)
  - Boll & Barth (1983)
  - Beers (1992)
- Since, controversy, contentiousness, and confusion

Neuropsychological Outcomes: Recent research

- Bottom line: clear initial neuropsychological effects that tend to resolve within days, weeks, months for vast majority of children
- Most methodologically rigorous studies suggest that school-age children and teens do not display persistent neuropsychological problems after a single uncomplicated mild TBI
  - Epidemiologic (e.g., Bijur, Haslum, & Golding, 1990)
  - Prospective controlled (e.g., Babikian et al., 2011; Fay et al., 1993; Mailard-Wormslerger et al., 2009; Ponsford et al., 1999)
  - Sport-related prospective (e.g., McCrea, 2008)
- Meta-analytic studies
  - Pediatric mild TBI (Babikian & Asarnow, 2009; Vu et al., 2011)
  - Sport-related concussion (Belanger & Vanderploeg, 2005)
  - Adult mild TBI (Binder et al., 1997; Schretlen & Shapiro, 2003; Belanger et al., 2005; Richter et al., 2011)
- Critical reviews
  - Pediatric: Carroll et al. (2004); Hung et al. (2014); Satz et al. (1997, 2001); Yeates & Taylor (2005); Yeates (2012)
  - Adult: Iverson (2005); McCrea (2008); McCrea et al. (2009)
**Performance-based vs. Subjective report**

- Neurobehavioral outcome can be measured with wide variety of tools

- Objective performance-based tests (e.g., cognitive, academic achievement, balance)
  - In school-age children, minimal evidence to suggest persistent problems in methodologically rigorous group studies after uncomplicated mTBI

**Subjective parent and/or child symptom report**

- Most pronounced symptomatology seen acutely
- For most children, symptoms tend to resolve over first days to weeks
- Symptoms persist for some months in a minority of children (in contrast to most performance-based data)
  - E.g., Yeates, Taylor, and colleagues; Barlow et al. (2010); Babcock et al. (2013)
  - Mixed samples
- Overall, sport-related etiologies associated with less persistent symptomatology
  - Why?
    - Less severe?
    - More motivated?

**College and High School Athletes**

- Based on 635 prospectively enrolled concussed high school and college athletes.
  - From McCrea, Ivensen, McAuliffe, P以及wait, Powell, Barr, & Kelly (2009).
What does background science mean for…

...neuropsychological management?

Mild TBI Clinical Care

• Needs
  • Medical, cognitive, emotional, social, school, athletic, family, etc.

• Potential contributors
  • Caregiver & child/teen, primary physician, other medical personnel, athletic staff, school personnel, neuropsychologist, other specialists (e.g., educational, rehabilitation, behavioral health)
Despite evidence of positive recovery in most cases, pediatric practitioners frequently see:

where problems attributed to mild TBI

Why do symptoms persist?

- Both injury and noninjury factors found to play a role
- Zemek et al (2013) "Minimal, and at times contradictory, evidence exists to associate clinically available factors with eventual development of postconcussive symptoms in children"
- Undoubtedly varies on case-by-case basis

Important clinical note

- In both TBI and orthopedically injured control groups, symptoms associated with increased family burden, parental distress, and decreased child quality of life so important to manage regardless of etiology (Ganesaglinam et al., 2008; Moran et al., 2012)
- Mild TBI, per se, not associated with health-related QOL but reported persistent symptoms are (Yeates et al., 2012)
TBI Related Factors

- More severe mild TBI (e.g., findings on imaging, need for hospitalization, LOC/PTA)
  - Levin et al. (2008); Yeates, Taylor, and colleagues; Babcock et al. (2013); Barlow et al. (2011); McCrea et al., 2013
- Multiple previous injuries
  - E.g., Guskiewicz et al., 2003; Brooks et al., 2013
  - But contradictory findings as well (e.g., Connery et al., 2014; McCrea et al., 2013)
- Explain more outcome variance relatively soon after injury (first days to weeks) than many months later
  - McNally et al. (2013)

Noninjury Factors

- "Postconcussive" symptoms nonspecific and occur in many other populations (e.g., typically developing, depression, general pain)

<table>
<thead>
<tr>
<th></th>
<th>Headache</th>
<th>Dizziness</th>
<th>Irritability</th>
<th>Memory Pax</th>
<th>Attention Pax</th>
</tr>
</thead>
<tbody>
<tr>
<td>College</td>
<td>36%</td>
<td>18%</td>
<td>36%</td>
<td>17%</td>
<td>42%</td>
</tr>
<tr>
<td>Pain</td>
<td>40%</td>
<td>67%</td>
<td>49%</td>
<td>33%</td>
<td>63%</td>
</tr>
<tr>
<td>Depression</td>
<td>37%</td>
<td>20%</td>
<td>42%</td>
<td>25%</td>
<td>54%</td>
</tr>
<tr>
<td>PI claimants</td>
<td>77%</td>
<td>41%</td>
<td>63%</td>
<td>46%</td>
<td>71%</td>
</tr>
<tr>
<td>(non-TBI)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mild TBI</td>
<td>42%</td>
<td>38%</td>
<td>28%</td>
<td>36%</td>
<td>25%</td>
</tr>
</tbody>
</table>


Other non-neurological factors associated with persistent "postconcussive" symptomatology

- Premorbid learning and psychosocial problems (Babikian et al., 2013; Peterson, Connery, Baker, & Kirkwood, 2015; Yeates et al., 2012)
- Premorbid symptoms (McNally et al., 2013)
- Maladaptive coping (Woodrome et al, 2011)
- Parental factors such as distress and anxiety (Olsson et al., 2013; Ponsford et al., 1999)
- Bodily injury and pain (Beaupre et al., 2012)
- Postinjury symptom exaggeration & feigning (Kirkwood & Kirk, 2010; Kirkwood et al., 2014; Araujo et al., 2014)
- Certain clinical management strategies?
  - e.g., "brain rest" (Thomas et al., 2014; Moor et al., 2015)
Good Old Days Bias: tendency to view child as healthier and higher functioning before the injury and to underestimate past problems

N = 412, recruited ED; followed by phone 1 and 3 months

At each time point, asked parents/kids to rate how many preinjury symptoms apparent

How many parents report zero symptoms preinjury?

- In ED: 35%
- At 1 and 3 months: 80%

Mild TBI a neuro-psychological condition and neuropsychologists key personnel in clinical management

Pilot Study: Neuropsychological Assessment as an Intervention for Persistent Symptoms after Pediatric Mild TBI (Kirkwood, Peterson, Connery & Baker)

- Interrupted time series design
- Prospectively enrolled 8-17 year olds referred for neuropsychological consultation because of concerns/questions about persistent symptoms after mild head injury
  - At time of enrollment, injury at least 2 months previous but no more than 1 year
  - Total of 81 children enrolled
  - 72 completed neuropsych consultation
    - 71/72 completed study
# Timeline

<table>
<thead>
<tr>
<th>Time Point 1</th>
<th>Time Point 2</th>
<th>Time Point 3</th>
<th>Time Point 4</th>
<th>Time Point 5</th>
<th>Time Point 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timing</td>
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</tr>
<tr>
<td>2+ Months Post Injury</td>
<td>1 Week Before Neuropsych Eval</td>
<td>Neuropsych Eval</td>
<td>1 Week After Neuropsych Eval</td>
<td>1 Month After Neuropsych Eval</td>
<td>3 Months After Neuropsych Eval</td>
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<td>Data Collection</td>
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</tr>
<tr>
<td>Telephone</td>
<td>Telephone</td>
<td>Face-to-Face</td>
<td>Telephone</td>
<td>Telephone</td>
<td>Telephone</td>
</tr>
<tr>
<td>Measures</td>
<td>Measures</td>
<td>Measures</td>
<td>Measures</td>
<td>Measures</td>
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</tbody>
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HBI: Health and Behavior Inventory  
PedsQL: Pediatric Quality of Life Inventory

## Neuropsych Battery

<table>
<thead>
<tr>
<th>Post-concussive symptomatology</th>
<th>Health Behavior Inventory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Validity</td>
<td>MSGT, TOMM, Rey Fit; Automatized Sequences; Digit Span; CVLT</td>
</tr>
<tr>
<td>Estimated cognitive ability</td>
<td>WASI-2 (two-subtest version)</td>
</tr>
<tr>
<td>Learning and memory</td>
<td>CVLT</td>
</tr>
<tr>
<td>Speed, attention, executive function</td>
<td>Wechsler Coding and DS subtests; Verbal Fluency Trail Making Test</td>
</tr>
<tr>
<td>Academic achievement</td>
<td>Letter-Word Identification, WJ-III</td>
</tr>
<tr>
<td>Psychosocial status</td>
<td>Parent &amp; Child BASC</td>
</tr>
</tbody>
</table>

### Preliminary Results

- Parent Satisfaction
  - 94.3% of parents reported being satisfied overall with the service
  - 97.2% of parents agreed or strongly agreed that the neuropsychologist provided a caring atmosphere
  - 97.2% of parents would recommend service to a friend
Preliminary Results

- Parent and child reported postconcussive symptoms

![Graph showing child and parent symptoms over time](image)

* Mean child symptoms 11 days postinjury. Yeates et al. sample recruited from ED (N = 181)
* Mean parent symptoms 11 days postinjury. Yeates et al. sample recruited from ED (N = 186)

- Do the effects reflect spontaneous recovery?
  - No relationship between symptom report and time since injury

![Graph showing correlation between symptom report and time since injury](image)

- Lots of questions remain
  - Quasi-experimental design
    - Will the results hold up when using more rigorous methodologies (eg, RCT)?
  - If so, what exactly about the neuropsych assessment affects change?
  - For which children/families?
  - Timing?

- But, pilot data promising and suggest role for neuropsychologists in clinical management of children with persistent symptomatology

Persistent Postconcussive Symptoms

Injury severity (e.g., structural pathology)

Premorbid functioning (e.g., symptoms, anxiety)

Clinical management

Expectations and attributions

Societal factors (e.g., litigation)

Motivation to get better

Child and family Coping

Personality factors

Concomitant post-injury factors (other injury, pain, depression, stress)

Adapted from Iverson et al. (2008)

Why make difference?
Help sort through which injury and noninjury variables are likely contributing to persistent problems after concussion and address identified variables

Why make difference?

• Correct misinformation & mismanagement
  • Eg. No reasonable study in children to support effectiveness of absolute or long-term rest
  • Lots of potential for iatrogenesis if recommend long-term “rest”

• Psychoeducation & Reassurance

Impact of Early Intervention on Outcome After Mild Traumatic Brain Injury in Children

Jennie Przybylo, MPH; Catherine Wilkinson, MEd; Andrea Kothbauer, MS; Peter Canner, M.D; Emily Tetrault, M.D; Gary J. Smith, M.D; Robert Nasca, Christopher J. Andridge, M.D; and Brian D. Boyles

Pediatrics 2001;108:1297

Benefits of Strict Rest After Acute Concussion: A Randomized Controlled Trial

The Concussion Program

Michael W. Kirkwood, Ph.D., ABPP/CN

Concussion Program
Children’s Hospital Colorado
Department of Rehabilitation Medicine

Michael.Kirkwood@ChildrensColorado.org