Informing the treatment of concussion in the schools with evidence-based assessment: School psychologists linking student, family and healthcare

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Disclosure Statement
Psychological Assessment Resources, Inc.
• Test Author (royalties)
  • Behavior Rating Inventory of Executive Function (BRIEF)
  • Post-Concussion Executive Inventory (PCEI)
  • Post-Concussion Symptom Inventory-2 (PCSI-2)
Many other tests & measures (no royalties)
  • Acute Concussion Evaluation (ACE) – office, ED
  • ACE Care Plan; Home/School Instructions
  • Post-Concussion Symptom Inventory – 5-7, 8-12, 13-18; Parent
  • BRIEF – Concussion Monitoring – Parent, Self-Report
  • Children’s Exertional Effects Rating Scale (ChEERS)
  • Concussion Learning Assessment & School Survey (CLASS) – Parent, Self-Report
  • Progressive Activities of Controlled Exertion (PACE) – Self Efficacy (Child, Parent)
  • Multimodal Assessment of Cognition & Symptoms (MACS)
  • Concussion Recognition & Response (CRR) – Parent/Coach app
  • Concussion Assessment & Response (CAR) – Medical app

Objectives
This session will help participants:
(1) Increase understanding of the underlying dysfunction of concussion, including pathophysiology, signs and symptoms, recovery trajectories, as they relate to manifestations in school;
(2) Gain knowledge and skills to perform competent evidence-based symptom-based assessments, and progress monitoring;
(3) Translate symptom assessments into individualized, symptom-targeted school-based interventions; and
(4) Identify school-based concussion management team members and collaborative modes of communication with the family and community healthcare providers.
**Background**

Concussion as ADHD in 1980

- ADHD
  - 1980: Most kids were evaluated and treated by specialists – or not at all
  - 2018: Most kids are evaluated/ treated by pediatricians and within schools
    - Refer Complex Cases

- Concussion
  - 2001: Most kids are evaluated and treated by specialists – or not at all
  - 2020?: Most kids are evaluated and treated by pediatricians and within schools
    - Refer Complex Cases

Concussion as the “new” ADHD

- Inattention/Impulsivity/Overactivity
  - “Typical” ADHD
    - Primary “Care” *
  - “Atypical” Recovery (>4 wks)
    - Speciality Care **

*School as a “primary care” setting
**School psychologist as a “specialist”
Concussion’s Medical Neighborhood
Connected Care

Points of Entry
- Parents/Coaches
- Group Leaders/Pears
- Peer (R&R)
- Urgent Care
- Athletic Trainers
- Primary Care

“Medical Home” Care
“Typical”

“Medical Home” Care
“Typical”

Continued Care
“Atypical”

Primary Care

1. Safety
2. Managed Return to Activity
   - School
   - Physical/Recreation/Sports
   - Social

Specialty Care

Rehabilitation Services

1. Safety
2. Managed Return to Activity
   - School
   - Physical/Recreation/Sports
   - Social

Four Corners Approach to Concussion Care

Family

Medical

Child/Teen
(Student, Athlete,
Son/Daughter,
Friend)

School

Sports/Recreation

Rewards of Working with Concussion

Typically,
- Not a long-term issue
- Not a lot of testing, functional assessment
- Intervention/consultation oriented
- Kids get better! In direct proportion to:
  - How early their needs are identified
  - How early interventions are put in place
  - Their needs being monitored regularly and interventions modified through recovery

BUILT FOR THE SCHOOL PSYCHOLOGIST!
Evolution of Concussion Knowledge

Vienna/Prague/Zurich/Berlin

What is the difference in concussion management in children as compared with adults? A systematic review

Gavin A Davis,1 Vicki Anderson,1 Fozas E Balzi,2 Gerard A Gioia,3 Christopher C Giza,4 William Meehan,5 Rosemarie Scolaro Moses,6 Laura Purcell7 Philip Schatz,7 Kathryn J Schneider,8 Michael Tuck,9 Keith Owen Yeates,1 Roger Zemek,2

ABSTRACT

AIM: To evaluate the evidence regarding the management of sport-related concussion (SRC) in children and adolescents. The eight subquestions included the effects of age on symptoms and outcomes,central and prolonged duration, the role of comprehensive neuropsychological tests (CNTs), the rate of rest, and strategies for return to school and return to sport (RTS).

Design: Systematic review

Statement on the management of SRC in 2016,1 but this paper did not include any child-specific recommendations. The CRGr meeting in Prague in 2004 focused on the paediatric population,2 and the Zurich 2009 meeting focused on the management statement in children, led by a panel of experts.3 This paper included an age limit of 10 years for applications of the recommendations, recommended a consensus

Berlin 2016

What are the new findings?

- Children and adolescents are expected to take up to 4 weeks to recover following sport-related concussion.
- The widespread routine use of baseline comprehensive neuropsychological testing is not recommended in children and adolescents.
- A brief period of cognitive and physical rest following sport-related concussion in children and adolescents should be followed with gradual symptom-based physical and cognitive activity.
- All schools should be encouraged to have a concussion prevention and management policy and should offer appropriate academic accommodations and support for students recovering from sport-related concussion.

Active School Management
(1) Increase understanding of the underlying dysfunction of concussion, including pathology, signs and symptoms, recovery trajectories, as they relate to manifestations in school.
**What is a concussion?**

- A bump, blow or jolt to the head or body that causes the brain to move rapidly back & forth
- Causes stretching of brain, causing chemical changes, and cell damage
- Causes change in how brain works (signs & symptoms)
- Once these changes occur, brain is more vulnerable to further injury and sensitive to increased stress

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**TBI in US Children**

- 2,700 Deaths
  - 4.5 per 100,000
- 37,000 Hospitalizations
  - 63.0 per 100,000

- Mild TBI = 90%

  - Pediatric Care
  - Urgent Care
  - [None]

  Emergency department

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**Many Causes**

- Motor Vehicle Collisions
- Falls
- Struck By/ Against
- Assaults
- Sports & Recreations
Concussion =
Traumatic Brain Injury

Brain Motion...
Pathophysiological Basis

- Stress and strain of force:
  - cell wall
  - diffuse axonal injury
- Massive ionic flux of potassium and calcium.
- Metabolic demands on cells exposed to ionic flux results in injury-induced diaschisis
  - loss of coupling between neuronal activation and cerebral blood flow,
  - Produces energy crisis
  - Mitochondrial dysfunction

Giza & Hovda, 2001; Hovda, in press

Neurometabolic Cascade Following Traumatic Brain Injury

Neurometabolic Cascade Following Traumatic Brain Injury

Giza & Hovda, 2001

Anatomical Timeline of a Concussion
Defining the Key Factors

- Pre-Injury Risks
- A. Injury Characteristics
- B. Symptom Assessment
- C. Risk Factors

CONCUSSION

- Pre-Injury Risks
- LOC <=10%
- Antegrade Amnesia 24-48%
- Neurocog dysfx & Post-Concuss Sx’s
- Hours - Days - Weeks+

- Sec-Min
- Sec-Hrs
- Sec-Min
- Sec-Hrs
Signs of a Concussion (what you observe)

**Cognitive**
- Appears dazed/stunned
- Confused about events (assignment or position)
- Answers questions more slowly
- Repeats questions/ forgets instruction or play
- Can’t recall events prior to or after the hit/fall

**Physical**
- Vomiting
- Loses consciousness
- Balance problems
- Moves clumsily
- Drowsy

**Behavior/ Emotion**
- Behavior or personality changes

Symptoms of a Concussion (what they feel and report)

**Physical**
- Headache
- Fatigue
- Visual problems (blurry/double)
- Nausea/vomiting
- Balance problems/ dizziness
- Sensitivity to light/noise
- Numbness/tingling

**Sleep**
- Sleeping more/less
- Trouble falling asleep
- Drowsiness

**Cognitive**
- Mental fogginess
- Difficulty concentrating
- Difficulty remembering
- Feeling slowed down

**Emotional**
- More emotional
- Irritable
- Sad
- Nervous

Sleep
- Sleeping more/less
- Trouble falling asleep
- Drowsiness

Persisting Symptom Culprits

- Headaches
- Fatigue
- Vestibular (dizziness, balance)
- Cognitive problems (attention, memory, executive function, speed)
- Anxiety/mood problems
Further Defining Concussion: Symptom Subtypes

- Headaches
- Vestibular
- Ocular-motor
- Cognitive
- Anxiety/mood problems

Associated conditions
- Sleep
- Cervical strain

Concussion Guidelines Step 2: Evidence for Subtype Classification

Brought to you by [Image]

Neurosurgery, 2019
Research literature still limited understanding of concussion recovery outcomes across full age range, and for boys and girls (IOM, 2013; CDC, 2016; Berlin, 2016; NIH, 2016).

- Largest pediatric-adolescent study (Zemek et al., 2016; n>3,000; age 5-18) indicates 70 ±10% symptom recovery within 4 weeks.
- And – Age, sex, injury type/severity matter!
- Don’t expect “7-10 days” for recovery!

(2) Gain knowledge and skills to perform competent evidence-based symptom-based assessments, and progress monitoring.
### Assessment & Management of Concussion

**Processes, Pathways & Tools**

<table>
<thead>
<tr>
<th>(Non-Medical) Recognize &amp; Respond</th>
<th>(Medical) Screen- Diagnose-Treat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home</td>
<td>Emergency Dept.</td>
</tr>
<tr>
<td>Recreation setting</td>
<td>Urgent Care</td>
</tr>
<tr>
<td>Sports setting</td>
<td>Primary Care</td>
</tr>
<tr>
<td>School</td>
<td>Specialty Care</td>
</tr>
<tr>
<td>Youth Group</td>
<td>Other Care</td>
</tr>
</tbody>
</table>

### Early Identification/ Early Treatment: A Shared Goal

- **Recognize & Respond**
  - Home
  - Recreation setting
  - Sports setting
  - School
  - Youth Group

- **Screen- Diagnose-Treat**
  - Emergency Dept.
  - Urgent Care
  - Primary Care
  - Specialty Care
  - Other Care

### CDC-inspired/funded Tool Development (2003-2017)

1. Acute Concussion Evaluation (ACE) – office, ED
2. ACE Care Plan; Home/School Instructions
3. Post-Concussion Symptom Inventory (PCS)
   - 5-7, 8-12, 13-18; Parent
5. Children’s Exertional Effects Rating Scale (CheERS)
7. Progressive Activities of Controlled Exertion (PACE) Self Efficacy (Child, Parent)
8. Multimodal Assessment of Cognition & Symptoms (MACS)
9. Tasks of Executive Control (TEC)
10. Concussion Recognition & Response (CRR) – Parent/Coach app
11. Concussion Assessment & Response (CARE) – Medical app
**Public Health Toolkits**

**Public Health model: Recognize & Respond**

**Triggers to Concussion Evaluation**

1. **Blow/Force to Head/Body**
   - Blunt force or deceleration/acceleration event

2. **Alteration of consciousness or mental status**

<table>
<thead>
<tr>
<th>Physical</th>
<th>Cognitive</th>
<th>Emotional</th>
<th>Sleep</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache</td>
<td>Concentrate</td>
<td>Irritability</td>
<td>More</td>
</tr>
<tr>
<td>Fatigue</td>
<td>Memory</td>
<td>Emotional</td>
<td>Less</td>
</tr>
<tr>
<td>Balance/</td>
<td>Speed of thinking</td>
<td>Sadness</td>
<td>Cannot</td>
</tr>
<tr>
<td>Dizziness</td>
<td>Thinking</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Post-Concussion Signs & Symptoms**

- Fatigue
- Memory
- Emotional
- Less
- Balance
- Speed of thinking
- Sadness
- Cannot
Concussion Assessment, Monitoring and Management Toolbox

Evidence-based Assessment

- In essence, we want our clinical assessment tools/ data to help predict outcomes
  - Likelihood of diagnosis
  - Time to recovery
  - Likelihood of prolonged/complicated recovery
  - Need for treatment
  - Return to school, necessary accommodations
  - Return to physical activity/ sports/ recreation
- Examine set of clinical factors that are predictive current status, or treatment needs

Evidence-based assessment:

- Refines the predictive capability of known risk factors, clinical measures, functional impairment to the likelihood of post-injury problems.
- Improves our understanding of probabilities for specific outcomes, allows better targeting of individualized treatments.
- Identifies when clinically important change has occurred beyond chance.
Clinical Questions

- Is this student’s symptom pattern consistent with a likely concussion?
- Is the student at high risk for prolonged recovery?
- Is this student at high risk for problems with academics?
- Has the student made clinically significant change in their functioning?

Predicting & Preventing Persistent Post-Concussion Problems in Pediatrics (5P)

Objective:

To develop and validate a clinical risk score for PPCI among children presenting to the emergency department.

5P Clinical Risk Score

12-point scale of predictors

- Demographic factors
- History
- Signs
- Clinical tests
- Symptoms

Clinical Risk Score for Persistent Postconcussion Symptoms Among Children With Acute Concussion in the ED

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Point Value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>3</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Gender (M:F)</td>
<td>1</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>History of previous head injury</td>
<td>2</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Signs (at least 2 of 6)</td>
<td>5</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Sleep disturbances</td>
<td>3</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Anxiety</td>
<td>2</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Depression</td>
<td>3</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Fatigue</td>
<td>3</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Cognitive impairment</td>
<td>3</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Memory disturbance</td>
<td>2</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Emotions</td>
<td>2</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Pain</td>
<td>2</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Non-painful symptoms</td>
<td>1</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

N=1701

5P Clinical Risk Score

- Demographic factors
- History
- Signs
- Clinical tests
- Symptoms
70% prediction accuracy vs. clinician prediction (55%)

Assessing Concussion
Critical Importance of History in Concussion Diagnosis & Mgt

- Concussion occurs within the context of the person’s developmental, medical, social and emotional/psychiatric history.
- A number of concussion “symptoms” mimic pre-existing behaviors or “symptoms” and must be distinguished.
- This must occur at the time of establishing the diagnosis as well as at the time of recovery.

Diagnostic Confidence

1. Was there a definite reported mechanism of injury?
2. Was there an onset of typical symptoms within 24-48 hours of the injury event?
3. Has there been gradual recovery or stability of symptoms over the first week of the injury?
4. Was there an alternative explanation for the symptoms?

Symptom Assessment

- Acute Concussion Evaluation (ACE)
- Post-Concussion Symptom Inventory (PCSI-2)
- Post-Concussion Executive Inventory (PCEI)
Acute Concussion Evaluation (ACE)

- ACE is a clinical protocol to assist diagnosis of mTBI/concussion in medical/school settings
- Ages 4-adult
- Elements of clinical assessment protocol are evidence-based
- Link to follow-up care via ACE Care Plan

Since June 2007

Heads Up Brain Injury in Your Practice

Improving Identification and Diagnosis of Mild Traumatic Brain Injury With Evidence: Psychometric Support for the Acute Concussion Evaluation

Objective: A series of standardized, validated assessment tools create a properly trained exchange with traumatic brain injury (TBI) patients, using cognitive and acute care settings. This study presents evidence of appropriate psychometrics properties for Acute Concussion Evaluation (ACE) with attention to research. Houston Concussion Evaluation: Results: Evidence for a proposed acute care tool developed, clinical usefulness explored using psychometric properties in acute care settings with both acute care patients. Keywords: role, concussion evaluation, attention, compliance, sideline benefits from injury, psychometric properties, ACME.
Acute Concussion Evaluation (ACE) Key Elements

A. Define Injury Characteristics
B. Assess for Symptoms (22) (Lovell & Collins, 1998)
C. Identify Risk Factors for Prolonged Recovery
D. Red Flags for Neurological Deterioration
E. Establish the Diagnosis
F. Plan Follow-Up Action / Referral

Acute Concussion Evaluation (ACE)

A. Injury Characteristics

Injury Description
Cause
Amnesia (retrograde, anterograde)
Loss of Consciousness (LOC), Seizures
Early Signs

<table>
<thead>
<tr>
<th>Injury Characteristics</th>
<th>Date/Time of Event</th>
<th>Sept. 7, 2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cause</td>
<td>Hit head on ground, blood in right temporal region, dazed initially but continued to play with no headache, felt sluggish and confused.</td>
<td></td>
</tr>
</tbody>
</table>

1. Amnesia (retrograde, anterograde)
2. Loss of Consciousness (LOC), Seizures
3. Early Signs
4. Dizziness
5. Memory Loss
6. Adverse Effects
7. Cognitive Changes
8. Headache
9. Nausea
10. Vomiting
11. Numbness
12. Tingling
13. Fatigue
14. Sleep Disturbance
15. Changes in Mood
16. Changes in Emotions
17. Changes in Behavior
18. Changes in Personality
19. Changes in Speech
20. Changes in Voice
21. Changes in Vision
22. Changes in Hearing

Acute Concussion Evaluation (ACE)

B. Symptom Checklist

C. Risk Factors for Protracted Recovery

Research findings have linked these risk factors to longer periods of recovery.
Acute Concussion Evaluation (ACE)

D. Red Flags for Neurological Deterioration

Physicians and parents/patients need to be aware of signs that signal the need for emergency care.

TABLE 8: Acute Concussion Evaluation symptoms report frequencies and symptom-symptom correlations

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Reporting frequencies, %</th>
<th>Non-fatal concussions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache</td>
<td>76</td>
<td>0.33%</td>
</tr>
<tr>
<td>Fatigue</td>
<td>80</td>
<td>0.52%</td>
</tr>
<tr>
<td>Feeling slowed down</td>
<td>46</td>
<td>0.51%</td>
</tr>
<tr>
<td>Difficulty concentrating</td>
<td>49</td>
<td>0.50%</td>
</tr>
<tr>
<td>Difficulty remembering</td>
<td>49</td>
<td>0.47%</td>
</tr>
<tr>
<td>Feeling dizzy</td>
<td>44</td>
<td>0.45%</td>
</tr>
<tr>
<td>Feeling unusually tired</td>
<td>49</td>
<td>0.43%</td>
</tr>
<tr>
<td>Sleeping more than usual</td>
<td>49</td>
<td>0.26%</td>
</tr>
<tr>
<td>Irritability</td>
<td>36</td>
<td>0.15%</td>
</tr>
<tr>
<td>More emotional</td>
<td>36</td>
<td>0.09%</td>
</tr>
<tr>
<td>Sensitive to light</td>
<td>36</td>
<td>0.12%</td>
</tr>
<tr>
<td>Sensitivity to noise</td>
<td>27</td>
<td>0.19%</td>
</tr>
<tr>
<td>Nausea</td>
<td>26</td>
<td>0.19%</td>
</tr>
<tr>
<td>Balance</td>
<td>32</td>
<td>0.19%</td>
</tr>
<tr>
<td>Trouble falling asleep</td>
<td>21</td>
<td>0.29%</td>
</tr>
<tr>
<td>Visual symptoms</td>
<td>20</td>
<td>0.05%</td>
</tr>
<tr>
<td>Neurosensory</td>
<td>18</td>
<td>0.36%</td>
</tr>
<tr>
<td>Sleeping less than usual</td>
<td>17</td>
<td>0.10%</td>
</tr>
<tr>
<td>Difficulty waking up</td>
<td>46</td>
<td>0.13%</td>
</tr>
<tr>
<td>Vomiting</td>
<td>4.5</td>
<td>0.13%</td>
</tr>
</tbody>
</table>

Tracking Symptom Status/Recovery
Post-Concussion Symptom Conceptualization

- "Static" symptom manifestation: symptoms that are present over period of time (days, weeks)
  - Assessed by traditional graded symptom scales
- "Dynamic" symptom manifestation: symptom presentation (and change) in response to stimulation/activity → Exertional effects
  - Assessed by dynamic symptom scale (using ecological momentary assessment-EMA)

Concept of RAPID score

- Retrospective-Adjusted Post-Injury Difference (RAPID) score is central, unique feature
- Addresses two essential questions:
  - Is there a change from pre to post injury functioning (i.e., does the symptom exist?)
  - Is there a change over post-injury time (i.e., is there recovery, worsening, no change?)
- Employ reliable change metrics to answer these questions

Concept of Reliable Change

- Purpose: behavior is intrinsically and naturally variable
- Errors of measurement are inherent and inevitable
- Change affects observed variability
- Challenge: to separate the variability due to change from the variability due to measurement error
Assessing Reliable Change in Neuropsychological Function

- Group change vs. individual change
- Many studies examine group change
- Change as statistically significant or clinically significant (meaningful)
- Clinical trials/clinical outcomes research are mostly interested in clinically meaningful change

Clinical Significance

"clinically meaningful" change

- Clinically, change needs to be large enough to make a difference.
- How much change is clinically significant to indicate "improvement" (especially if they are in the average range)?
- For change to be clinically significant, it needs to be statistically reliable. We must be able to determine that change is "real."*
- Reliability of change is a prerequisite for "clinically significant" change

*Jacobson et al. (1984)
How to determine if change is statistically reliable/"real" – Reliable Change

Reliable change
Reliable Change Index (RCI)


Reliable Change Index (RCI)
- Provides a metric regarding the extent to which change in an individual’s scores falls beyond the range that could be attributed to the instrument’s measurement variability or the effects of repeated ratings.
- Provides helpful guideline for determining when changes from two scores are beyond expectation based on measure’s stability and expected change for two ratings.
- RCI metric incorporates measure’s inherent normal variability (SD) with its stability (test-retest reliability), producing SEM and Sediff - establishing confidence intervals.
- RCIs of RAPID score indicate clinically meaningful difference beyond 80% or 90% CI range.

Interpreting Reliable Change (Evidence-driven)

When interpreting change, ask two fundamental questions.

1. Are the post-injury symptom ratings clinically different from the pre-injury ratings?
   - RAPID score indicates change from preinjury to post-injury status, reveals clinically significant problems above/beyond the preinjury state.
   - Identifies clinically significant problem toward which to direct intervention strategies.
Interpreting Reliable Change (Evidence-driven)

When interpreting change, ask two fundamental questions.

2. Is there a significant change in symptom ratings over time/relative to previous assessment?
   - Compare RAPID scores between the two visits to reveal recovery gains over time
   - Indicates recovery progress, and whether interventions require adjustment

Concussion Symptom Assessment Toolkit

- Post-Concussion Symptom Inventory (PCSI)
  - Physical
  - Sleep/Fatigue
  - Cognitive
  - Emotional
- Post-Concussion Executive Inventory
  - Working Memory
  - Task Initiation/Completion
  - Emotional Control

Post-Concussion Symptom Inventory (PCSI)

Child Report
- Age 5-7 – 5 items
- Age 8-12 – 17 items
- Age 13-18 – 21 items

Parent Report
- Age 5-18 – 20 items

Assesses:
- 4 symptom categories
- Pre- and Post-Injury ratings to identify injury-specific effects
- Developmentally sensitive
- Psychometric support
- Included in the NIH CDE toolkit
- Used worldwide
Additional Clinical Information
Assessing & Monitoring Key Executive Functions

- Problems with executive functions are common following brain injuries (Chapman et al., 2010; Isquith, Roth, & Gioia, 2013).
- Routinely assessed in an ecologically valid manner (Gioia, Kenworthy, & Isquith, 2010).
- The BRIEF is most widely used measure of the executive functions following brain injury in children/adolescents.
Assessing & Monitoring Key Executive Functions

- BRIEF has demonstrated sensitivity to executive function deficits associated with TBI of all severity levels
- We modified the BRIEF to include scales sensitive to concussion
  - Working Memory
  - Emotional Control
  - Task Initiation/Completion

Post-Concussion Executive Inventory (PCEI)

Description

- Originally, component in 2003 CDC mTBI outcomes grant
- Two forms: Parent (18 items), Self (16 items)
- Focused domains: Working Memory, Task Initiation/Completion, Emotional Control
- Ratings of pre-injury status (Retrospective Baseline (RBL), post-injury status

- Central score is the Retrospective Adjusted Post-Injury Difference (RAPID) score (Post-Pre)
- Detect change in executive function domains/items from pre to post-injury, and across recovery.
- Guides intervention supports across recovery
Assessing & Monitoring Key Executive Functions

Problems with executive functions are common following brain injuries (Chapman et al., 2010; Isquith, Roth, & Gioia, 2013).

- Routinely assessed in an ecologically valid manner (Gioia, Kenworthy, & Isquith, 2010).
- The BRIEF is the most widely used measure of executive functions following brain injury in children/adolescents.
- BRIEF has demonstrated sensitivity to executive function deficits associated with TBI of all severity levels.
- We modified the BRIEF to include scales sensitive to concussion (Working Memory, Emotional Control, Task Initiation/Completion).
**Post-Concussion Executive Inventory (PCEI)**

**Psychometrics**
- Samples: Asymptomatic, symptomatic mTBI; ages 5-18
  - Completed RBL, Post-Injury ratings
  - Across 3 assessment time points
- Reliability
  - Internal consistency of scales
  - Stability
- Validity
  - Construct
  - Relationship to other measures
  - Sensitivity to clinical condition

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**RCIs applied to the Post-Concussion Executive Inventory**

**Score Summary Table**

<table>
<thead>
<tr>
<th>Scale</th>
<th>RAPID Score</th>
<th>80%</th>
<th>90%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working Memory</td>
<td>8</td>
<td>0-2</td>
<td>3</td>
</tr>
<tr>
<td>Emotional Control</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Task Completion</td>
<td>4</td>
<td>0-3</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td>0-6</td>
<td>7-8</td>
</tr>
</tbody>
</table>

---

**Executive Function Change over Time**

<table>
<thead>
<tr>
<th>Scale</th>
<th>RAPID Score</th>
<th>Difference Score</th>
<th>80%</th>
<th>90%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Visit 1</td>
<td>Visit 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Working Memory</td>
<td>8</td>
<td>0-2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emotional Control</td>
<td>1</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task Completion</td>
<td>4</td>
<td>0-3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td>0-6</td>
<td>3</td>
<td>7-8</td>
</tr>
</tbody>
</table>

---

**Concussion recovery analysis between Visit 1 and Visit 2**

<table>
<thead>
<tr>
<th>Scale</th>
<th>RAPID Score</th>
<th>Difference Score</th>
<th>80%</th>
<th>90%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Visit 1</td>
<td>Visit 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Working Memory</td>
<td>8</td>
<td>0-2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emotional Control</td>
<td>1</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task Completion</td>
<td>4</td>
<td>0-3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td>0-6</td>
<td>3</td>
<td>7-8</td>
</tr>
</tbody>
</table>

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**Concussion recovery analysis between Visit 2 and Visit 3**

<table>
<thead>
<tr>
<th>Scale</th>
<th>RAPID Score</th>
<th>Difference Score</th>
<th>80%</th>
<th>90%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Visit 2</td>
<td>Visit 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Working Memory</td>
<td>8</td>
<td>0-2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emotional Control</td>
<td>1</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task Completion</td>
<td>4</td>
<td>0-3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td>0-6</td>
<td>3</td>
<td>7-8</td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th>Scale</th>
<th>RAPID Score</th>
<th>Difference Score</th>
<th>80%</th>
<th>90%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Visit 2</td>
<td>Visit 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Working Memory</td>
<td>8</td>
<td>0-2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emotional Control</td>
<td>1</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task Completion</td>
<td>4</td>
<td>0-3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td>0-6</td>
<td>3</td>
<td>7-8</td>
</tr>
</tbody>
</table>
Relationship between the PCSI-2 and PCEI

### Table 5.9

Correlations Between Parent PCSI-2 RAPID and PCEI RAPID Scores

<table>
<thead>
<tr>
<th>PCEI Scale</th>
<th>Physical</th>
<th>Emotional</th>
<th>Cognitive</th>
<th>Sleep/Fatigue</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working Memory</td>
<td>.81</td>
<td>.52</td>
<td>.78</td>
<td>.53</td>
<td>.79</td>
</tr>
<tr>
<td>Emotional Control</td>
<td>.26</td>
<td>.45</td>
<td>.66</td>
<td>.18</td>
<td>.52</td>
</tr>
<tr>
<td>Inhibit</td>
<td>.38</td>
<td>.43</td>
<td>.62</td>
<td>.56</td>
<td>.48</td>
</tr>
<tr>
<td>Total</td>
<td>.28</td>
<td>.46</td>
<td>.70</td>
<td>.49</td>
<td>.67</td>
</tr>
</tbody>
</table>

Notes: n = 2152. All correlations significant at p < .001. PCSI-2 = PostConcussion Symptom Inventory-2. PCEI = PostConcussion Executive Inventory. (Burdick & Logan, 2016). Not all children completed the PCEI.

---

Relationship between the PCSI-2 and PCEI

### Table 6.3

PCSI-2 Adolescent Self-Report Form Scale

<table>
<thead>
<tr>
<th>PCSI-2 Scale</th>
<th>Physical</th>
<th>Emotional</th>
<th>Cognitive</th>
<th>Sleep/Fatigue</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working Memory</td>
<td>.51**</td>
<td>.38**</td>
<td>.79**</td>
<td>.48**</td>
<td>.73**</td>
</tr>
<tr>
<td>Emotional Control</td>
<td>.33**</td>
<td>.54**</td>
<td>.38**</td>
<td>.28**</td>
<td>.44**</td>
</tr>
<tr>
<td>Task Completion</td>
<td>.53**</td>
<td>.33**</td>
<td>.69**</td>
<td>.44**</td>
<td>.64**</td>
</tr>
<tr>
<td>Total</td>
<td>.61**</td>
<td>.46**</td>
<td>.77**</td>
<td>.49**</td>
<td>.73**</td>
</tr>
</tbody>
</table>

Notes: PCSI-2 = PostConcussion Symptom Inventory-2. PCEI = PostConcussion Executive Inventory. (Burdick & Logan, 2016). Not all children completed the PCEI.

---

Relationship between the PCSI-2 and PCEI

### Table 6.4

PCSI-2 Child Self-Report Form Scale

<table>
<thead>
<tr>
<th>PCSI-2 Scale</th>
<th>Physical</th>
<th>Emotional</th>
<th>Cognitive</th>
<th>Sleep/Fatigue</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working Memory</td>
<td>.62**</td>
<td>.42**</td>
<td>.75**</td>
<td>.44**</td>
<td>.70**</td>
</tr>
<tr>
<td>Emotional Control</td>
<td>.37**</td>
<td>.51**</td>
<td>.38**</td>
<td>.17**</td>
<td>.45**</td>
</tr>
<tr>
<td>Task Completion</td>
<td>.56**</td>
<td>.35**</td>
<td>.76**</td>
<td>.46**</td>
<td>.68**</td>
</tr>
<tr>
<td>Total</td>
<td>.64**</td>
<td>.47**</td>
<td>.79**</td>
<td>.47**</td>
<td>.74**</td>
</tr>
</tbody>
</table>

Notes: PCSI-2 = PostConcussion Symptom Inventory-2. PCEI = PostConcussion Executive Inventory. (Burdick & Logan, 2016). Not all children completed the PCEI.
Dynamic Symptom Assessment & Tracking

Exertional “Effects” Response
As Target of Interest/ Intervention
- Exertional Effects = symptom exacerbation following physical, cognitive, emotional activity
- Possible signal that brain’s neurometabolism pushed beyond tolerable limits
- Child’s sensitivity to symptom exacerbation/exertional effects hypothesized as indicator of injury status.
- Possible treatment/management implications (i.e., Controlled Exertion)

Cognitive & Physical Intolerance (% Reporting Exertional Effects)

<table>
<thead>
<tr>
<th></th>
<th>Elementary (n=88)</th>
<th>Middle (n=138)</th>
<th>High School (n=206)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demand</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Cognitive</td>
<td>47.7</td>
<td>52.5</td>
<td>62.5</td>
</tr>
<tr>
<td>Physical</td>
<td>12.5</td>
<td>20.3</td>
<td>16.5</td>
</tr>
</tbody>
</table>

Degree of intolerance/exertional effects indicates need to manage activity demands at school
Psychosocial Impact

- Invisible injury
  - TBI not appreciated
  - Look “normal”
- Cut off from social group (team)
- Loss of identity
- Pressures to be “normal”, return & contribute
- Pressure of schoolwork

Assessing Academic Effects

- How does concussion affect school learning and performance?
- What kinds of problems?
  - Symptom-specific
  - General
- What kinds of stresses is the student feeling?
- What subjects are affected?
- What supports are needed? Are they getting?
### Comprehension Learning Assessment & School Survey (CLASS) Self-report - Initial Assessment

#### General Information:
- **Name:**
- **Class:**
- ** Grade:**
- **Age:**
- **Today’s Date:**

**Student Performance:** Check all that apply:
- A
- B
- C
- D
- E
- F

**How has recent academic performance been affecting your school functioning and performance?**
- Not at all
- Slightly
- Moderately
- Very

#### Think about the past ten days and tell us whether the following school problems have been a concern because of your concussion:

<table>
<thead>
<tr>
<th>Issue</th>
<th>Not at All</th>
<th>A Little</th>
<th>Somewhat</th>
<th>A lot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difficulty staying on task</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difficulty understanding new material</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difficulty working on homework</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trouble reading</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difficulty distinguishing colors in class</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Headaches interfering with classwork</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Headaches interfering with homework</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tiring easily during the school day</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difficulty staying awake during homework</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difficulty staying awake during classwork</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difficulty staying awake during sleep</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Please check one column for each of the following topics to indicate which supports you need and/or are receiving because of your concussions:

- **Supports Needed?**
- **Do you have it?**

<table>
<thead>
<tr>
<th>Support</th>
<th>No</th>
<th>Yes</th>
<th>Too Much</th>
<th>Yes but not enough</th>
<th>Don’t need</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medication(s)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shorter classes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Real breaks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extra time to complete work</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rest/break</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted test: cheating/nacht, make-up, no patterns</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current work load: reduced or varied</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hobbies/interests reduced or varied</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cleveland testing task: new work</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Applying an Evidence-Based Assessment Model to Identify Students at Risk for Perceived Academic Problems following Concussion

- **Title:**
- **Authors:**
- **Journal:**
- **Volume:**
- **Issue:**
- **Publication Date:**
- **DOI:**
Predicting Academic Outcomes

- ROC modeling of academic outcome
- Predicting "good" vs "challenged" academic outcomes (CLASS)
- Predictors: Post-concussion symptoms (PCSI), executive dysfunction (BRIEF), exertion (ChEERS)

Test-Based Assessment

- Concussion can produce impairment of neuropsychological function in children and adults
  - Attention, memory, speed, executive function
- Strengths: Assessment of neuropsychological function provides measurable outcome of injury
- Limitations: Other factors can influence performance and reporting; findings do not stand alone
  - Test findings are best understood as one tool within a multidimensional, multidisciplinary model
- Training in the proper administration is critical to obtain valid results (Vaughan et al., 2014; Moser et al., 2011)
- Interpretation of findings requires higher level of training/expertise

Predicting Academic Outcome (and likely need for service)

<table>
<thead>
<tr>
<th>Index test</th>
<th>Area under curve</th>
<th>Std error</th>
<th>$p$ value</th>
<th>Lower</th>
<th>Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical BRIEF Self-Report</td>
<td>0.70</td>
<td>0.04</td>
<td>&lt; 0.001</td>
<td>0.56</td>
<td>0.84</td>
</tr>
<tr>
<td>PCSI Self-Retant</td>
<td>0.70</td>
<td>0.04</td>
<td>&lt; 0.001</td>
<td>0.56</td>
<td>0.84</td>
</tr>
<tr>
<td>PCSI Parent Report</td>
<td>0.79</td>
<td>0.06</td>
<td>&lt; 0.001</td>
<td>0.59</td>
<td>0.89</td>
</tr>
<tr>
<td>Medical BRIEF Parent Report</td>
<td>0.73</td>
<td>0.06</td>
<td>&lt; 0.001</td>
<td>0.54</td>
<td>0.83</td>
</tr>
<tr>
<td>Executive Function Index</td>
<td>0.76</td>
<td>0.06</td>
<td>&lt; 0.001</td>
<td>0.55</td>
<td>0.86</td>
</tr>
<tr>
<td>Cognitive performance (Raven's)</td>
<td>0.64</td>
<td>0.05</td>
<td>&lt; 0.001</td>
<td>0.47</td>
<td>0.81</td>
</tr>
<tr>
<td>Processing Speed</td>
<td>0.65</td>
<td>0.05</td>
<td>&lt; 0.001</td>
<td>0.47</td>
<td>0.81</td>
</tr>
<tr>
<td>Written Expression</td>
<td>0.67</td>
<td>0.06</td>
<td>&lt; 0.001</td>
<td>0.49</td>
<td>0.85</td>
</tr>
</tbody>
</table>

Note: Benchmarks provided by Roe and Hans (2014) indicate that 70% correct indicates a generally normal, 50% indicates a moderately impaired level, and < 50% indicates a severely impaired level. cut-off scores for grades 7-9 and 10-12 are 0.65 and 0.60, respectively. AUC = area under curve; $p$ = probability; CI = confidence interval; ROC = receiver operating characteristic.
Cognitive Testing

- Traditional
  - WISC/WAIS or DAS-II
  - Working Memory, Processing Speed
  - Verbal Fluency (D-KEFS)
  - Auditory Consonant Trigrams
  - KTEA WJ-3
    - Reading, Math Fluency

Cognitive Testing

- Computer Administered
  - Immediate Post-concussion Assessment & Cognitive Testing (ImPACT)
  - CNS Vital Signs
  - Cog Sport

(3) Translate symptom assessments into individualized, symptom-targeted school-based interventions
TREATING CONCUSSION/
MILD TBI

Treatment (Zurich)

Concussion management
The cornerstone of concussion management is physical and
cognitive rest until the acute symptoms resolve and then a
graded programme of exertion prior to medical clearance and
RTT. The current published evidence evaluating the effect of
rest following a sports-related concussion is sparse. An initial
period of rest in the acute symptomatic period following injury
(24-48 h) may be of benefit. Further research to evaluate the
long-term outcome of rest, and the optimal amount and type
of rest, is needed. In the absence of evidence-based recommenda-
tions, a sensible approach involves the gradual return to
school and social activities (prior to contact sports) in a
manner that does not result in a significant exacerbation of
symptoms.

Historic Approach(es) to
Concussion Treatment

REST
REST
REST

TIME

(CISG, AAP, etc.)
General Principles of Recovery

- No additional forces to head/brain
- Get good sleep
- Managing Activity – Exertion Relationship
  - Not over-exerting body or brain
  - Not under-exerting body or brain
  - Avoid activities that produce symptoms

Ways to over-exert

- Physical
- Cognitive (concentration, learning, memory)
- Emotional

Managed Activity

Concussion in Sports: Pseudoconcussive Activity

No additional forces to head/brain
Get good sleep
Managing Activity – Exertion Relationship
Not over-exerting body or brain
Not under-exerting body or brain
Avoid activities that produce symptoms
Ways to over-exert
Physical
Cognitive (concentration, learning, memory)
Emotional

Not too Little, Not Too Much

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

Thomas et al. (2015) Pediatrics
Progressive Activities of Controlled Exertion (PACE)

1. Set the Positive Foundation for Recovery
2. Define the Parameters of the Activity-Exertion Schedule
3. Skill Teaching: Activity-Exertion Monitoring/Management
4. Reinforcing the Progressive Path to Recovery

Active Recovery Management (ARM) Key Messages

You will get better.
You will improve and recover.
You have control of your activity.
Your efforts to control your activity and time will pay off.
Find your “sweet spot” of activity.

Effect of Concussion on School Learning & Performance

Effect of School Learning & Performance on Concussion Recovery
Return to Learn
Life in School

School:
- Kid’s Major "Job" is new learning/ acquiring knowledge
- Practicing incompletely learned knowledge (HW)
- Mental and physical exertion is essential to new learning/ practice

ALSO:
- Social with peers
- Interacting with teachers
- Managing the environment
- Academic pressure

Epidemiology of Recovery
Our Best Guess

- Research literature is still limited with respect to understanding concussion recovery outcomes across full age range, and for boys and girls (IOM, 2013).
- Perhaps 70 +/-% recovery within 4 weeks (Zemek et al, 2016).

Recovery Supports must plan for a window from several days to several months (school, physical, social).

Academic Effects of Concussion in Children and Adolescents

Academic Effects of Concussion in Children and Adolescents

- The aim of this study is to study the nature and extent of the adverse academic effects
  - Ransom et al. (2015) Pediatrics - Define types of academic challenges in concussed students 5-18 years
  - Results: Non-recovered (RC-) group reported higher levels of concern, more school-related problems than RC+ group.
  - High school students report higher levels of problems.
  - Higher symptom burden associated with greater reported academic problems.
  - Significantly greater impairment on cognitive testing in RC- group.
  - Summary: empirical evidence of concussion's impact on learning/ performance reported by students. Identifies academic effects to target interventions.
What kinds of school problems are you having SINCE YOUR INJURY?
Ransom et al. (2015)

<table>
<thead>
<tr>
<th>Type of Problem</th>
<th>Elementary</th>
<th>Middle</th>
<th>High School</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headaches interfering</td>
<td>53%</td>
<td>73%</td>
<td>71%</td>
</tr>
<tr>
<td>Can’t pay attention</td>
<td>47%</td>
<td>58%</td>
<td>66%</td>
</tr>
<tr>
<td>Feeling too tired</td>
<td>53%</td>
<td>61%</td>
<td>52%</td>
</tr>
<tr>
<td>Homework taking much longer</td>
<td>35%</td>
<td>48%</td>
<td>63%*</td>
</tr>
<tr>
<td>Difficulty understanding material</td>
<td>25%</td>
<td>46%</td>
<td>54%</td>
</tr>
<tr>
<td>Difficulty studying for tests</td>
<td>18%</td>
<td>36%</td>
<td>53%*</td>
</tr>
<tr>
<td>Difficulty taking Notes</td>
<td>18%</td>
<td>17%</td>
<td>35%*</td>
</tr>
</tbody>
</table>

Average # reported: 2.53 (2.1) 3.37 (1.7) 3.92 (2.1)

* Significant (p<.05) difference across grade level

Which classes/subjects are you having trouble with SINCE YOUR INJURY?

<table>
<thead>
<tr>
<th>Type of Problem</th>
<th>Elementary</th>
<th>Middle</th>
<th>High School</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading</td>
<td>33.3</td>
<td>37.0</td>
<td>46.3</td>
</tr>
<tr>
<td>Math</td>
<td>29.6</td>
<td>54.3</td>
<td>59.2</td>
</tr>
<tr>
<td>Science</td>
<td>14.8</td>
<td>29.7</td>
<td>46.3</td>
</tr>
<tr>
<td>Social Studies</td>
<td>14.8</td>
<td>33.1</td>
<td>36.1</td>
</tr>
<tr>
<td>Foreign Language</td>
<td>7.4</td>
<td>33.7</td>
<td>32.0</td>
</tr>
<tr>
<td>Art</td>
<td>0.0</td>
<td>5.5</td>
<td>3.4</td>
</tr>
<tr>
<td>None</td>
<td>14.8</td>
<td>16.3</td>
<td>12.9</td>
</tr>
</tbody>
</table>

Predicting Academic Outcomes

Applying an Evidence-Based Assessment Model to Identify Students at Risk for Perceived Academic Problems following Concussion

Ransom et al., 2015

Predicting Academic Outcomes

<table>
<thead>
<tr>
<th>Type of Problem</th>
<th>Elementary</th>
<th>Middle</th>
<th>High School</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading</td>
<td>33.3</td>
<td>37.0</td>
<td>46.3</td>
</tr>
<tr>
<td>Math</td>
<td>29.6</td>
<td>54.3</td>
<td>59.2</td>
</tr>
<tr>
<td>Science</td>
<td>14.8</td>
<td>29.7</td>
<td>46.3</td>
</tr>
<tr>
<td>Social Studies</td>
<td>14.8</td>
<td>33.1</td>
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<td>Foreign Language</td>
<td>7.4</td>
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<tr>
<td>Art</td>
<td>0.0</td>
<td>5.5</td>
<td>3.4</td>
</tr>
<tr>
<td>None</td>
<td>14.8</td>
<td>16.3</td>
<td>12.9</td>
</tr>
</tbody>
</table>
Cognitive & Physical Demands & Symptoms (% Reporting Exertional Effects)

<table>
<thead>
<tr>
<th></th>
<th>Elementary (n=88)</th>
<th>Middle (n=138)</th>
<th>High School (n=206)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demand</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Cognitive</td>
<td>47.7</td>
<td>52.5</td>
<td>62.5</td>
</tr>
<tr>
<td>Physical</td>
<td>12.5</td>
<td>20.3</td>
<td>16.5</td>
</tr>
</tbody>
</table>

Degree of exertional effects indicates Need to Manage Activity Demands during School Day (w/ accommodations)

And don’t forget the Psychosocial Issues!

- Invisible injury
  - TBI not appreciated
  - Look “normal”
- Cut off from social group (team)
- Loss of identity
- Pressures to be “normal”, return & contribute
- Pressure of schoolwork

Symptoms of a Concussion (what they feel and report)

- Physical
  - Headache
  - Fatigue
  - Visual problems (blurry/’double’)
  - Nausea/vomiting
  - Ear
  - Sinus
  - Sensitivity to light/noise
  - Numbness/tingling
- Sleep
  - Sleeping more/less
  - Trouble falling asleep
  - Drowsiness
- Cognitive
  - Mental fogginess
  - Difficulty concentrating
  - Difficulty remembering
  - Feeling slowed down
- Emotional
  - More emotional
  - Irritable
  - Sad
  - Nervous

Targets for Supports
(Today) A Student is Identified with a Mild TBI/Concussion

What Do You Do (Tomorrow)?

Goals of Proper School Return

• Prepared Systems: trained medical & school providers
• Initial medical evaluation of student & communication of symptom profile to school
• School Concussion Management Team (CMT) translates symptom profile into necessary academic adjustments & accommodations
• Regular monitoring of symptom and academic progress in school, home
• CMT (Re)Adjust accommodations with progress/recovery
• Coordination/communication between Student/Family, Medical Provider, School, Athletics
What Berlin has to say about School Return (Purcell et al, 2018)

Five factors influence return to school post-concussion:

1. **Age**: Adolescents tend to take longer to recover and return to school; adolescents more concerned about the negative academic effects of concussion than younger children.

2. **Symptom load/severity**: Students with greater number/ severity of symptoms tend to take longer to return to school, require more academic accommodations, longer to recover.

3. **Course load**: Certain subjects pose greater problems for students returning to school: math (#1) reading/language arts (#2), then science, social studies.

4. **Medical follow-up**: Students who receive RTS letter in ED, medical follow-up after ED more likely to receive academic accommodations

5. **School resources**: Schools with concussion policies that include student/ parent concussion education tend to:
   - provide more accommodations and greater variety of accommodations to students
   - be more likely to form concussion management teams at school to facilitate return to school
   - have students and parents who are more knowledgeable about concussion (Glang et al. 2014)
15A. To assist children returning to school following mTBI, medical and school-based teams should counsel the student and family regarding the process of gradually increasing the duration and intensity of academic activities as tolerated, with the goal of increasing participation without significantly exacerbating symptoms. (Level B)

15B. Return to school protocols should be customized based on the severity of postconcussion symptoms in children with mTBI as determined jointly by medical and school-based teams. (Level B)

15C. For any student with prolonged symptoms that interfere with academic performance, school-based teams should assess the educational needs of that student and determine the student’s need for additional educational supports, including those described under pertinent federal statutes (e.g., Section 504, IDEA). (Level B) [see 15F]

15D. Postconcussion symptoms and academic progress in school should be monitored collaboratively by the student, family, healthcare provider, and school teams, who jointly determine what modifications or accommodations are needed to maintain an academic workload without significantly exacerbating symptoms. (high, Level B)

15E. The provision of educational supports should be monitored and adjusted on an ongoing basis by the school-based team until the student’s academic performance has returned to preinjury levels. (moderate; Level B)

15F. For students who demonstrate prolonged symptoms and academic difficulties despite an active treatment approach, healthcare providers should refer the child for a formal evaluation by a specialist in pediatric mTBI. (moderate; Level B) [see 15C]
(4) Identify school-based concussion management team members and collaborative modes of communication with the family and community healthcare providers

Who is on the School Team?
Concussion Management Team
– Medical Monitor
– Academic Monitor

School nurse, psychologist, athletic trainer
Guidance counselor
Administrator
Teacher(s)
Healthcare Provider(s)
Family

Expertise within the Team
Healthcare Provider
• - knowledge of injury
• - symptom manifestations
• - recovery path
• - comorbid health/developmental factors
  * TASK: DIAGNOSE, DEFINE, REDEFINE NEEDS
### Medical System Role in Setting Up School Return

**CDC “Discharge” Education**

**Key Components**

1. Educate about concussions (definition, risks)
2. Reasons to go/return to Emerg. Dept. (red flags)
3. Safety restrictions: sports, other risk activities
4. Activity restriction & management
5. School/ work return guidance
6. Medical follow up

---

### Healthcare Provider Input

- **Diagnose**
- **(Re)Define**
- **Recommend/Suggest**

---

### Expertise within the Team

- **Healthcare Provider**: knowledge of injury, symptom manifestations, recovery path, comorbid health/developmental factors
  - **TASK**: DIAGNOSE, DEFINE, REDEFINE NEEDS
- **School**: Teaching/learning, school environment
  - **TASK**: TRANSLATE INJURY INFO INTO SUPPORTS TO OPTIMIZE LEARNING, ADJUST SUPPORTS
School-based Concussion Management Team

Roles

– Medical monitor:
  • monitors the symptom status of the student, using standardized symptom scale
  • Liaisons with community medical provider
  • Reports status to academic monitor

– Academic monitor:
  • oversees & guides academic support process - Day 1 to recovery
  • Links student symptom status with accommodations
  • Liaisons with, student, teachers and medical monitor

How long do students need support?

- Perhaps 70 +/-% with symptom recovery within 4 weeks (Zemek et al, 2016)
- Therefore, 30% beyond 4 weeks.

Recovery Supports must plan for a window from several days to several months (school, physical, social).

School Care Pathway

Return to School

<table>
<thead>
<tr>
<th>Step</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Symptom Monitor: Meets with student to re-assess symptom status, notes any changes</td>
</tr>
<tr>
<td>2</td>
<td>Academic Monitor: Makes final academic management plan changes; consults student on plan</td>
</tr>
<tr>
<td>3</td>
<td>Academic Management Plan Implemented</td>
</tr>
<tr>
<td>4</td>
<td>Academic Monitor: Updates teaching tools if needed</td>
</tr>
<tr>
<td>5</td>
<td>Progress Monitoring</td>
</tr>
<tr>
<td>6</td>
<td>Academic Management Plan Adjusted</td>
</tr>
<tr>
<td>7</td>
<td>Recovery/Return to Full Academic Participation</td>
</tr>
<tr>
<td>8</td>
<td>Additional Supports Reserved</td>
</tr>
</tbody>
</table>

Referred to ECP for further assessment of complicating factors, additional programming supports
School Psychologist Pathway (suggested)

School Psychologist Role:
- Early Team Assessment & Planning
- Later Referral
- Not At All

Student Evaluation
- Symptoms
- Exertion
- Academic Effects
- Psychological Effects

Assessment Tools
- Broad-based symptoms
  - ACE, PCSI
- Specific Sx (cognitive)
  - PCEI
- Exertional effects
  - CHEERS
- Academic effects
  - CLASS

Academic Planning
- Symptom Targets & Supports
- Academic Management
- Activity Management

Social-Emotional Support
- Irritability
- Emotional Control
- Anxiety
- Stress
- Mood
- Self-Efficacy (Recovery Control)

Concussion Management Team

Targets for Student Support and Treatment
JT - Care Pathway

- JT - 14 year old 9th grade male; plays soccer, basketball, lacrosse; no hx of LD, ADHD, emotional dx. One previous concussion (age 8, riding bike).
- Injured yesterday (10/18) skateboarding, fell and struck the back of his head; no LOC but does not recall the fall or 5-10 minutes prior; 10 minutes of PTA; confusion.
- Pediatrician evaluation: ACE identifies physical, cognitive, emotional and sleep symptoms (Total score = 12; concussion diagnosed
- Recommends 2 days off school. Return To School letter provided.

Acute Concussion Evaluation (ACE) 6. Symptom Checklist

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical (12)</td>
<td></td>
</tr>
<tr>
<td>Headache</td>
<td>0</td>
</tr>
<tr>
<td>Nausea</td>
<td>0</td>
</tr>
<tr>
<td>Numbness</td>
<td>0</td>
</tr>
<tr>
<td>Trembling</td>
<td>0</td>
</tr>
<tr>
<td>Balance problems</td>
<td>0</td>
</tr>
<tr>
<td>Fatigue</td>
<td>0</td>
</tr>
<tr>
<td>Emotional (12)</td>
<td></td>
</tr>
<tr>
<td>Anxiety</td>
<td>0</td>
</tr>
<tr>
<td>Irritability</td>
<td>0</td>
</tr>
<tr>
<td>Sensitivity to light</td>
<td>0</td>
</tr>
<tr>
<td>Sleep disturbance</td>
<td>0</td>
</tr>
<tr>
<td>Physical activity</td>
<td>0</td>
</tr>
<tr>
<td>Cognitive activity</td>
<td>0</td>
</tr>
<tr>
<td>Emotions</td>
<td>0</td>
</tr>
<tr>
<td>Overall severity</td>
<td>0</td>
</tr>
</tbody>
</table>

Total score: 12 (Concussion diagnosed)
JT – School Evaluation & Support Plan

- Presents to school Day 3 post-injury; RTS letter provided
- Symptom & Academic Effects evaluation
  - Acute Concussion Evaluation (ACE)
  - Post-Concussion Symptom Inventory-2 (PCSI-2)
  - Post-Concussion Executive Inventory (PCEI)
  - Academic Effects (CLASS)
  - Exertion ratings
- PCSI-2:
  - Physical: Headaches, dizziness, balance problems, sensitivity to light, blurry vision
  - Cognitive: Fogginess, problems concentrating, slowed thinking
  - Emotional: Irritability
- Deep fatigue: fatigue, drowsiness, sleeping more than usual

Symptom Targeted Academic Management Plan (STAMP)

Below, please use the symptoms they are currently experiencing. To promote recovery, the student will be provided with the following interventions/accommodations that support their academic training and performance:

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Intervention in place</th>
<th>Management considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seizure &amp; Headache</td>
<td>Pain management strategies</td>
<td>Management considerations</td>
</tr>
<tr>
<td>Visual &amp; Hearing</td>
<td>Vision &amp; hearing support strategies</td>
<td>Management considerations</td>
</tr>
<tr>
<td>Emotional Distress</td>
<td>Emotional support strategies</td>
<td>Management considerations</td>
</tr>
<tr>
<td>Fatigue</td>
<td>Fatigue management strategies</td>
<td>Management considerations</td>
</tr>
<tr>
<td>Attention Deficit</td>
<td>Attention management strategies</td>
<td>Management considerations</td>
</tr>
</tbody>
</table>

Presents to school Day 3 post-injury; RTS letter provided
Symptom & Academic Effects evaluation
- Acute Concussion Evaluation (ACE)
- Post-Concussion Symptom Inventory-2 (PCSI-2)
- Post-Concussion Executive Inventory (PCEI)
- Academic Effects (CLASS)
- Exertion ratings
- PCSI-2:
  - Physical: Headaches, dizziness, balance problems, sensitivity to light, blurry vision
  - Cognitive: Fogginess, problems concentrating, slowed thinking
  - Emotional: Irritability
- Deep fatigue: fatigue, drowsiness, sleeping more than usual
JT (cont)

- PostConcussion Executive Inventory:
  - Difficulties with working memory, task completion; mild emotional (dys)control
  - Physical & cognitive activity worsens symptoms
  - CLASS: Moderately concerned
    - Academic problems
    - Stress
    - Classes affected

Exertional Effects Index (EEI) = 24
Gradual Return to School
Six Stages with Recommended Activity Level

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
<th>Activity Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No return, at home</td>
<td>No level required</td>
</tr>
<tr>
<td>1</td>
<td>Gradual Return to School, Partial Day (1-3 hours)</td>
<td>Minimal expectations for productivity.</td>
</tr>
<tr>
<td>2</td>
<td>Full Day, Maximal Supports (required throughout day)</td>
<td>Minimal to moderate expectations for productivity.</td>
</tr>
<tr>
<td>3</td>
<td>Return to Full Day, Moderate Supports (provided in response to symptoms during day)</td>
<td>Moderate to high expectations for productivity.</td>
</tr>
<tr>
<td>4</td>
<td>Return to Full Day, Minimal Supports (Monitor initial progress)</td>
<td>Moderate to high expectations for productivity.</td>
</tr>
<tr>
<td>5</td>
<td>Full Return, No Supports Needed</td>
<td>Max. expectations for productivity.</td>
</tr>
</tbody>
</table>

Day 1: Maintain low level cognitive and physical activity. No prolonged concentration.
Cognitive Readiness Challenge: As symptoms improve, try reading or math challenge task for 10-30 minutes; assess for symptom increase.
Attend 1-3 classes, intersperse rest breaks.

Day 2:
- Attend most classes, with 2-3 rest breaks (20-30'); begin quizzes.
- Moderate HW (60-90')
- Moderate expectations for productivity. Design schedule for make-up work.

Day 3:
- Attend all classes with 1-2 rest breaks (20-30'); begin modified tests (breaks, extra time). HW (90+')
- Moderate- maximum expectations for productivity.

Day 4:
- Attend all classes with 0-1 rest breaks (20-30'); begin modified tests (breaks, extra time). HW (90+')
- Moderate- maximum expectations for productivity.

Day 5:
- Full class schedule, no rest breaks.
- Max. expectations for productivity.

Begin to address make-up work.
The Case of Ellie  
A Case for the Neighborhood

- Age 13 girl
- Injured during Cheer practice – Thurs. 2/23
  - Base position: Flyer fell on her, fell and hit back of head on floor
- History: ADHD (w 504 plan), anxiety, migraine headaches, sleep difficulties (6-7 hrs/night)

Ellie (cont.)

- Initial Sx: severe global pain in head, nausea, dizziness, sensitivity to light, balance off, no cognitive or emotional symptoms reported.
- Sat out of practice: coaches called mother.
- Taken to local Emergency Dept; CT scan (normal), general physical/ neuro exam normal, given Zofran.
- No activity recommended but no discharge instructions and no specific school instructions.
- Referred to pediatrician and SCORE clinic.
Ellie (cont.)
- Did not attend school next day, slept most of day. Headaches over weekend. No nausea/ dizziness
- Returned to school Monday and Tuesday. School aware of injury but no specific restriction about gym; teachers made her play dodgeball (safer than bball!)
- Hit in head (left posterior). Nausea, headache increased.
- Saw pediatrician next morning. Recommended no school rest of week with progressive return and accommodations - extended time, rest breaks
- 3 Week period of recovery

Problems, Challenges, Opportunities
- Positives:
  - Initial coach (non-medical) recognition & response
  - Family understanding and advocacy
  - Primary care: appropriate evaluation & recommendations
- Problems:
  - ED: no symptom report, no discharge ed/ instructions, no school communication (Return to School letter)
  - School: Despite being aware of injury (as per mother), no protocol in place, no knowledge of risks and precautions, PE teacher uninformed
  - Primary care: delayed access, no communication of current symptoms; prescription pad for recommendations
- Opportunity
  - (Re) Education, implementation of standard protocols – role definition, communication between systems, safety precautions, accommodations/ management strategies

Summary
- Most children & adolescents recover from concussion within 1-4 weeks
- Concussions can have a significant effect on the injured student’s school learning

NEW TREATMENT APPROACH:
- Day 1-3 (5-7*): Initial restriction of activity with good nighttime sleep
- Day 4+ (8+*): Individualized progressive cognitive and physical activity with monitored symptom management
- Return to School requires medical-school teamwork
- Schools need Concussion Management Teams to provide systematic, coordinated support services

*More significant symptom load
Summary

- Concussion care is a team sport. Communication, collaboration, coordination!
- Implement the Berlin/CDC rec’s for Return to School!
- Medical & school expertise must be coordinated & collaborative
- Systematic Return to School policy and pathway is critical!
- Understanding student’s unique symptom profile is critical to delivering effective support (STAMP).
- Regular monitoring of student’s symptoms, adjusting types & intensity of supports is critically important.

School psychologists can play an important role in supporting the student with concussion.
- Apply your assessment expertise to define symptom targets to support
- Use your skills with interventions to understand, accommodate, monitor & readjust supports based on student’s symptoms
- Get in the Game!

Rewards of Working with Concussion

What to Do?
- Join the Concussion Mgt Team
- Help develop a Concussion Mgt Team
- Use the Pathway(s)
- Apply your good skills in evidence-based assessment, consultation & intervention
Concussion/ mTBI
CDC Educational Materials

www.cdc.gov/headsup

Heads Up: Concussion in High School Sports
Heads Up: Concussion in Youth Sports
Heads Up: Concussion in Your Practice
Heads Up to Schools: Know Your Concussion ABCs

References


Contact Information
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