Pediatric Traumatic Brain Injury: Long Term Academic and Adjustment Outcomes

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HELIX CONFERENCE: High Expectations for Students with Low Incidence Disabilities
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Learning Objectives

At the conclusion of the session the participants should be able to:

- Describe vulnerability of young children to effects of TBI

- Describe typical changes in IQ, academic skills, and psychological health experienced by youth with TBI

- Identify factors associated with more favorable outcomes
Overview of Topics

- Background information: TBI, epidemiology, severity
- Developmental concepts
- Outcomes in young children
- Outcomes in school-aged children and adolescents
- Family and environmental factors that influence outcomes
What is a Traumatic Brain Injury?

CDC definition of TBI

- Blow, bump, or jolt to the head or a penetrating head injury that disrupts the normal function of the brain

- Varies from “mild” --brief alteration in mental status or consciousness to “severe”– extended period of unconsciousness
Classification of Severity of TBI

- **Glasgow Coma Scale**
  
  Eye, Motor, Verbal response

  - Severe: 3-8
  - Moderate: 9-12
  - Mild: 13-15

- **Neuroimaging findings**

  - Mild TBI: Ø
  - Complicated mild TBI: Contusion or hemorrhage on CT
Brain collides with skull

Brain is violently moved and stretched within the skull
Biomechanics

- Rotational forces
  - brain not of uniform density
  - shaking/rotational acceleration produce shear forces
**Age and External Cause of TBI**

**FIGURE 2:** Estimated Average Annual Rates of Traumatic Brain Injury-Related Emergency Department Visits, Hospitalizations, and Deaths, by Age Group, United States, 2002–2006

Children, older adolescents, and adults aged 65 years and older were more likely to sustain a TBI.

**FIGURE 6:** Estimated Average Percentage of Annual Traumatic Brain Injury-Combined Emergency Department Visits, Hospitalizations, and Deaths Among Children 0 to 14 Years, by External Cause, United States, 2002–2006

Very young children aged 0 to 4 years had the highest rate of TBI-related emergency department visits (1,256 per 100,000 population), followed by older adolescents aged 15 to 19 years (757 per 100,000). However, the highest rates of TBI-related hospitalization and death occurred among adults aged 75 years and older (339 per 100,000 and 57 per 100,000, respectively).
Epidemiology of TBI

- TBI is most common cause of death and acquired brain injury among youth
- Incidence rate 180/100,000 hospitalized cases
- Over 17,000 children permanently disabled each year
- Profound and lifelong influences on daily functioning and transition to adulthood
Epidemiology of mild TBI

- High incidence

  In US, >650,000/year ages 0-14 seek hospital attention
  - 80% to 90% of TBI are mild
  - Estimated 32% children with mTBI are seen in ED
  An additional ~840K seek community care office/clinic (66%) or urgent care (2%)
  Incidence substantially increased in magnitude from 2004-2013
  - 1-2 million sport-related concussions annually

- Even if only a small proportion have negative outcomes, concussion places a significant burden on medical and educational systems

Zogg, *The Epidemiology of Pediatric Head Injury Treated Outside of Hospital Emergency Departments*, Epidemiology, 2018.
Trajectory of Recovery from Mild, Moderate, and Severe TBI

Babikian & Asarnow, 2009
Assessing Changes In Developmental Trajectory

- Estimating the long-term impact of pediatric TBI is difficult since the injury interacts with the moving target of ongoing brain and behavioral development.

- Developmental variables, including age at injury, time since injury, and sex are critically important to inform our understanding of the impact of TBI on both initial recovery and on subsequent development.

- TBI sustained at different stages during childhood may uniquely affect the trajectory of brain development and connectivity, leading to a downstream impact on neuropsychological functioning.

- To assess developmental vulnerability and resilience factors, need to consider preinjury functioning of the child and family, and assess future development in relation to injury comparison groups and healthy children.
Developmental Trajectory after TBI

- **Typical**
- **Moderate TBI**
- **Severe TBI**

Preinjury, 2 months, 6 months, 1 year, 5 years
Developmental Trajectory after TBI

- Lag
- Inc. Deficit
- Latent Deficit
- Arrest

Preinjury, 2 months, 6 months, 1 year, 5 years
Sequence of Cortical Gray Matter Maturation

Right lateral and top views of the dynamic sequence of GM maturation over the cortical surface. The side bar shows a color representation in units of GM volume. The initial frames depict regions of interest in the cortex as described for Fig. 1.

Gogtay et al., 2004; PNAS
Long-Term Changes Following Early Pediatric TBI
Factors Influencing Outcome from TBI

Injury Severity
- Glasgow Coma Score
- Intracranial Injury

Personal Factors
- Pre-injury Function
- Executive Function
- Body Function

Developmental
- Social
- Behavioral
- Cognitive

Participation
- School
- Community
- Home

Family Environment
- Family Function
- Income
- Parental Education
- Insurance Status

Environment

Community Environment
- School Supports
- Health Services
- Rural/Urban
Overview of Topics

- Outcomes in young children
The Impact of Injury in Young Children

- Infants and preschoolers are particularly vulnerable to the adverse effects of traumatic brain injury (TBI)

- The goal is to return them to their previous level of functioning and to continue to make developmentally appropriate gains

- Identification of early markers of later neurobehavioral outcomes is critically important to guide efforts to detect and intervene with children at high risk for adverse outcomes
Fig. 1. Both IQ and motor scores were reduced by severe TBI throughout the 24-month follow-up. Motor scores were significantly lower than composite IQ scores.
The Impact of Injury in Young Children: Sample

- Longitudinal, prospective study examining development during the first three years after injury children ages 0 to 15 years of age

- Youngest cohort age 0-30 months at injury
  - 116 TBI
    - 45 mild
    - 52 complicated-mild/moderate
    - 19 severe
  - 43 orthopedic injuries (OI)

- Recruited from Level 1 Trauma Centers at 2 sites
  - 66% were hospitalized
  - 34% from ED or observation unit

Keenan et al., J Neurotrauma 2018
The Impact of Injury in Young Children: Measures

- Ages and Stages Questionnaires-3 Parent Survey
  - Screens communication, gross motor, fine motor, problem solving, and personal-social areas
  - Mean score in each area ~50, SD ~ 10
  - Scores categorized as:
    - Appropriate
    - Monitoring: >1 < 2 SD below mean
    - Needs assessment: > 2 SD

- Good sensitivity (.86) and specificity (.85) for identifying children needing follow-up

Keenan et al, J Neurotrauma, 2018
The Impact of Injury in Young Children: Outcomes

Percentage of Children with Orthopedic or Brain Injury Scoring At or Below Appropriate Level on Communication Scale: Preinjury and 3 Months After Injury

<table>
<thead>
<tr>
<th></th>
<th>Orthopedic</th>
<th>Traumatic Brain Injury</th>
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<tbody>
<tr>
<td></td>
<td>Mild</td>
<td>cMild/Mod</td>
</tr>
<tr>
<td>preinjury</td>
<td>81</td>
<td>71</td>
</tr>
<tr>
<td>3 months after injury</td>
<td>88</td>
<td>75</td>
</tr>
<tr>
<td>appropriate</td>
<td>87</td>
<td>82</td>
</tr>
<tr>
<td>monitor</td>
<td>11</td>
<td>13</td>
</tr>
<tr>
<td>assess</td>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>15</td>
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</tbody>
</table>
ASQ-3 Scores 3 Months After TBI Relative to OI Group Controlling for Preinjury Ratings

Lower = more concerns

Group effect:  p = .02  p = .03  p = .51
ASQ-3 Scores 3 Months After TBI Relative to OI Group Controlling for Preinjury Ratings

Lower = more concerns

**Problem Solving**

- Mild
- Cmild/Mod
- Severe

**Personal-Social**

Group effect:  
- Problem Solving: p = .11
- Personal-Social: p = .01
ASQ-3 Scores 3 Months After TBI Relative to OI Group Controlling for Preinjury Ratings

Higher = more concerns

ASQ: Social Emotional Total

Group effect:  p = .001
Age at Injury in Infants and Young Children

(A) ASQ Communication
(B) ASQ Gross Motor
(C) ASQ Problem Solving

Age at Injury:
- 0 to <6 mos
- 6 to <12 mos
- 12 to <24 mos
- 24 to <31 mos
Ages and Stages-3 and Social-Emotional appear to be sensitive to developmental changes after injury across cognitive, motor, and socio-emotional domains.

- Relative to OI, TBI group showed significant reduction in communication, gross motor, personal-social, and social-emotional areas.

May provide means of screening preinjury level of functioning.

- About 25% of children with severe TBI were rated as functioning ≤ 2 SD below mean in 4 of 6 areas preinjury.
### Long-Term Follow-up of TBI Sustained in Early Childhood

<table>
<thead>
<tr>
<th></th>
<th>M (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age at Injury (mos)</td>
<td>21.2 (21.9)</td>
</tr>
<tr>
<td>Injury to Test Interval (mos)</td>
<td>68.3 (15.4)</td>
</tr>
<tr>
<td>Lowest GCS score</td>
<td>9.1(4.5)</td>
</tr>
<tr>
<td>Impaired Consciousness</td>
<td>3.1(5.0)</td>
</tr>
<tr>
<td>Glasgow Outcome Scale-discharge (n)</td>
<td></td>
</tr>
<tr>
<td>Good recovery</td>
<td>10</td>
</tr>
<tr>
<td>Moderate/Severe Disability</td>
<td>13</td>
</tr>
</tbody>
</table>

Ewing-Cobbs et al., J Neurosurg 2006
Growth curve modelling of IQ scores: Mental development index scores from Bayley Scales of Infant Development for evaluations prior to age 3; Stanford-Binet IV composite score for age > 3
Stanford-Binet IV Scores by Group

![Bar chart showing T scores for Binet subtests by group.](image)

- **T Score**
- **Binet Subtest**
- **TBI**
- **Comparison**

- † p < 0.10
- * p < 0.01

Vocabulary Pattern Analysis Memory for Sentences Bead Memory
Woodcock-Johnson III Tests of Reading Achievement

Bar chart showing standard scores for various reading subtests:

- Letter-Word
- Word Attack
- Reading Fluency
- Passage Comprehension

Comparison:

- TBI

Statistical significance:

† p < 0.10
* p < 0.01
Gray Oral Reading Tests IV

![Graph showing performance in different subtests with asterisks indicating statistically significant differences at p < 0.05.](image)

- **Fluency**: Standard Score
- **Accuracy**: Standard Score
- **Comprehension**: Standard Score

* *p < .05
Woodcock-Johnson III Tests of Math Achievement

![Bar chart showing standard scores for different math subtests: Calculation, Applied Problems, and Math Fluency. The comparison group shows significantly higher scores in Calculation and Applied Problems compared to the TBI group, indicated by asterisks. There is a p-value of less than 0.01 for these differences.]
Woodcock-Johnson III Tests of Oral and Written Language Achievement

![Bar chart showing standard scores for Oral Comprehension, Spelling, and Writing Fluency for TBI and Comparison groups.](chart.png)
School competence predicted by parent-reported executive dys/function; direct and indirect effects through SES

Arnett et al., 2013
BRIEF/P METACOGNITION INDEX

TBI severity only significant for age 5+. Note elevated ratings in preschool group with mild TBI.
Academic Performance: Young Children

- TBI adverse impact on functional academic performance
- 48% of children retained or required special education placement—underestimate
- Odds unfavorable academic outcome 18 times greater in TBI than comparison children (95 CI=0.006, 0.477)
- Similar to effects noted in older children and adolescents
Individual rates of impairment (>1 SD below mean = 16th percentile) were significantly higher than population expectations in mild, moderate and severe TBI groups:

- Perceptual Organization: 20-44%
- Processing Speed: 30-61%
- Adaptive Behavior: 15-53%

Rates of impairment similar for Executive Function and Social Skills scores across TBI groups.

Anderson et al., 2012, J Int Devl Neurosci
Young children with TBI may be especially vulnerable to long-term problems in:

A) Executive functions
B) Academic skills
C) Motor skills
D) All of the above
Overview of Topics

- Outcomes in school-aged children and adolescents
DTI in Identical Twins Discordant for Severe TBI During Adolescence: Persistent Deficit

Ewing-Cobbs et al., Am J Neuroradiol, 2006

Figure 8. DTI in identical twins discordant for severe TBI. Note the reduction of white matter in column A and callosal and orbitofrontal atrophy in column B. Tractography in column C shows diminution of the arcuate, inferior longitudinal, and uncinate fasciculi (green=association, blue=projection, & red=commissural fibers)
- Jaffe et al (1993) IQ and achievement largest and most consistent areas of difficulty after pediatric TBI

- IQ studies—consistently show lower IQ scores following severe than mild or moderate TBI; scores increase over first 6 months after injury, then plateau, PIQ < VIQ
Figure 5: Impact of diffuse early brain injury (traumatic) and age at insult on intellectual function up to 2.25 years post-insult (ETBI = injury ≤ 7 years; LTBI = injury ≥ 8 years). Adapted from Anderson et al. (2005a).
Despite some initial improvement, cross-sectional and longitudinal studies did not show late changes; substantial deficits persist in IQ and EF.

A: acute to post-acute
B: chronic

Babikian & Asarnow, 2009
Longitudinal follow-up of academic skills after mild-moderate or severe TBI sustained at ages 5-15; follow-up 2 (Ewing-Cobbs et al., 1998) and 5 years after injury (Ewing-Cobbs et al., 2004)

At 2 years, despite average mean achievement test scores in word recognition, spelling, and reading comprehension and low average calculation scores, 79% of severely injured patients repeated a grade and/or required special education supports.

5 years after injury, different rates of skill development related to age at injury and severity of injury.
By 6 years after early childhood TBI, the number of children with complicated-mild/moderate TBI receiving academic support services increased significantly; rates for children with severe TBI were stable over time.

Prasad et al., 2016
School Services by Injury Severity

- Formal Plan
- Reading Intervention
- Content Mastery
- Self-Contained
- Self-Contained Half-time
- Classroom Accommodations
- Tutors at School
- Grade Repeated

Percentage of Students

- CM: Moderate
- Severe
This study examined the provision of school services for students with TBI 1 year after they returned to school. We also sought to determine what factors might predict the receipt of those services. Our results show that nearly half of the students in the study received formal educational services through an IEP 1 year after returning to school. Yet, the remaining half of the students (47%) received informal or no services 1 year after returning to school following a TBI. Sex was the most influential factor predicting whether students received formal educational services.

<table>
<thead>
<tr>
<th>Educational accommodation</th>
<th>n (%)</th>
</tr>
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<tbody>
<tr>
<td>Extra time for tests</td>
<td>34 (45.9)</td>
</tr>
<tr>
<td>Extra time for assignments</td>
<td>29 (39.2)</td>
</tr>
<tr>
<td>Placement in resource room or learning center</td>
<td>28 (37.8)</td>
</tr>
<tr>
<td>Extra help from the teacher during class</td>
<td>27 (36.5)</td>
</tr>
<tr>
<td>Speech/language</td>
<td>25 (33.8)</td>
</tr>
<tr>
<td>Extra help from the teacher outside of class</td>
<td>23 (31.1)</td>
</tr>
<tr>
<td>Other test accommodations</td>
<td>21 (28.4)</td>
</tr>
<tr>
<td>Modified schedule</td>
<td>21 (28.4)</td>
</tr>
<tr>
<td>Use of notes during tests</td>
<td>20 (27.0)</td>
</tr>
<tr>
<td>Physical/motor</td>
<td>20 (27.0)</td>
</tr>
<tr>
<td>In school counseling</td>
<td>19 (25.7)</td>
</tr>
<tr>
<td>Vision/hearing</td>
<td>18 (24.3)</td>
</tr>
<tr>
<td>Small group instruction in regular classroom</td>
<td>16 (21.6)</td>
</tr>
<tr>
<td>Peer assistance</td>
<td>16 (21.6)</td>
</tr>
<tr>
<td>Relocation of desk</td>
<td>16 (21.6)</td>
</tr>
<tr>
<td>Teaching assistant (one-to-one) in some classes</td>
<td>14 (18.9)</td>
</tr>
<tr>
<td>Help with mobility</td>
<td>8 (10.8)</td>
</tr>
<tr>
<td>Teaching assistant (one-to-one) in all classes</td>
<td>7 (9.5)</td>
</tr>
<tr>
<td>Note taker</td>
<td>7 (9.5)</td>
</tr>
<tr>
<td>Visual aids</td>
<td>7 (9.5)</td>
</tr>
<tr>
<td>Minimization of stimuli</td>
<td>7 (9.5)</td>
</tr>
<tr>
<td>Tape recorder</td>
<td>2 (2.7)</td>
</tr>
</tbody>
</table>

Special education category at T2

Special education (IEP) 26 (35.1)
Special education (IEP + 504) 7 (9.5)
504 plan 6 (8.1)
Informal or no special services 35 (47.3)
Children with severe injuries showed less growth in word recognition over time. Adolescents with severe TBI had lowest intercept and greater acceleration of growth over time in arithmetic; growth decelerated over time in young children with severe injury.

Ewing-Cobbs et al., 2003
### Demographic Variables: Current Study

<table>
<thead>
<tr>
<th></th>
<th>TBI Group (n=44)</th>
<th>OI Group (n=43)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age at Injury mos M/SD</td>
<td>131.3/34.4</td>
<td>124.2/35.3</td>
</tr>
<tr>
<td>Sex (n) M/F</td>
<td>32/12</td>
<td>26/17</td>
</tr>
<tr>
<td>Race/Ethnicity (n) W/H/B/O</td>
<td>20/13/7/4</td>
<td>15/14/10/4</td>
</tr>
<tr>
<td>Hollingshead Index M/SD</td>
<td>38.0/14.9</td>
<td>41.4/13.4</td>
</tr>
<tr>
<td>Cause of Injury (n)*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MVC</td>
<td>24</td>
<td>5</td>
</tr>
<tr>
<td>Vehicle/pedestrian</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>Sports/play</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>Fall</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>Other</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Severity of TBI (n) CM/M/S</td>
<td></td>
<td>3/8/33</td>
</tr>
</tbody>
</table>

* p < .05
Academic Achievement Scores - Reading

Test of Word Reading Efficiency

- TOWRE Sight Word Reading
- TOWRE Phonemic Decoding

Gray Oral Reading Tests IV

- GORT-4 Rate
- GORT-4 Comprehension

* indicates significant difference between TBI and EI groups.
Academic Achievement Scores - Written Language

Woodcock-Johnson III Tests of Written Language

TBI  |  EI
---|---
WJ-III Spelling  |  |
WJ-III Writing Fluency  |  |

Test of Written Language

TBI  |  EI
---|---
TOWL Thematic Maturity  |  |
Academic Achievement Scores - Math

Woodcock-Johnson III Tests of Math Achievement
Association Pathways

Superior Longitudinal Fasciculus
- Sight Word Reading
- Phonemic Decoding
- Spelling
- Narrative Writing
- Calculation
- Applied Problems

Inferior Fronto-Occipital Fasciculus
- Narrative Writing
Projection and Association Pathways

Corticospinal Tract
- Written Narrative
- Writing Fluency

Cingulum Bundle
- Written Narrative
- Writing Fluency
- Reading Fluency

Anterior Thalamic Radiation
- Written Narrative
- Writing Fluency
- Calculation
- Applied Problems
Association Pathway

Uncinate Fasciculus

Applied Problems
Pathway Integrity Mediated Effect of TBI on Writing Fluency

Total Effect: $c: -9.81^*$

Group → ATR FA* ($ab_1: -6.17$, CI: (-12.13, -1.76), $c': -3.64, ns$)

Group → CB FA* ($ab_2: -7.50$, CI: (-14.64, -2.38), $c': -2.30, ns$)

Group → CST FA* ($ab_3: -4.25$, CI: (-9.55, -0.96), $c': -5.56, ns$)

Writing Fluency

$b_1: 280.40^{**}$

$b_2: 258.67^{***}$

$b_3: 286.68^{**}$
After moderate or severe TBI, the pattern of recovery over time often shows:

A) Catchup of skills by 2 years after injury

B) No growth of skills over time

C) Initial improvement but persistent reduction in skills

D) Continued decline of skills over time
Ratings of Affective Problems were > in preschool and school-aged mild-moderate to severe TBI than in adolescents

Keenan et al., J Neurotrauma, 2018
Child Behavior Checklist: Age X Time

ADHD Problems > over time in preschool and < in adolescents

Affective Problems > over time in preschool and < in school-aged group

Keenan et al., J Neurotrauma 2018
Child Behavior Checklist: Age Effects

Wade et al., JHTR, 2020
After severe TBI, problems often persist in the following areas:

A) Intellectual performance
B) Academic skills
C) Anxiety and depression
D) All of the above
Psychological health consequences of TBI often include all of the following except:

A) Externalizing problems
B) Psychosis
C) Post-traumatic stress
D) ADHD symptoms
Diagnosis of Concussion

4th Zurich consensus statement:
After direct or indirect force to the head, the suspected diagnosis of concussion can include one or more of the following clinical domains:

- Symptoms: somatic (headache), cognitive (feeling in a fog), and/or emotional (anxiety)
- Physical signs (loss of consciousness, amnesia)
- Behavioral changes (irritability)
- Cognitive impairment (slowed reaction times)
- Sleep disturbance (insomnia)

ICD-10
Nonspecific term to describe transient alterations/LOC following closed head injuries. Requires ≥ 1 symptom in at least 3 of the 4 core symptom categories: somatic, cognitive, emotional, sleep/fatigue.
Post-concussive Symptoms: Mild TBI

- PCS include changes in physical, cognitive, emotional, and sleep/fatigue domains.

- Resolve in approximately 70% of children within a month of mTBI (Barlow 2015); however, a significant minority of children experience prolonged symptoms persisting 3 to 12 months after injury (Barlow 2015; Ponsford 1999; Taylor 2010; Yeates 2009).

- Preinjury PCS (Barlow 2015; Iverson 2015; Olsson 2013) and mental health problems (Iverson 2017) are significant predictors of post-injury PCS.

- Both injury and non-injury factors predict persistent PCS.
PCS1 total outcomes by injury group

- Generalized linear mixed models controlling for pre-injury adjustment and symptoms
- mTBI and cmTBI groups showed significant increases in somatic, emotional, cognitive, and fatigue factors at 3 months relative to the OI group across the follow-up.
- mTBI/cmTBI did not differ significantly from each other.
- Pre-existing affective problems, poverty, and family dysfunction were vulnerability factors; social capital was protective.

Ewing-Cobbs et al., Pediatrics, 2018
Girls had higher unadjusted post-injury symptoms than boys in all areas of the PCSI-P despite similar pre-injury PCS.
Family and environmental factors that influence outcomes
Family and environmental factors influence both cognitive and behavioral outcomes.

Vulnerability factors

- Less advantaged backgrounds
- Income at or below poverty level for family size
- Worse family functioning

Protective factors

- Cohesive, communicative family
- Social capital
  - Connection to community
  - Perceived personal, family, neighborhood, and spiritual community support
Children with severe TBI from families with low resources have a disproportionately high level of social problems.

Yeates et al, 2004
Parenting Style

Figure 1. Adjusted Mean Levels of Functional Impairment by Group at Low/High Levels of Authoritarian Parenting

Figure 2. Adjusted Mean Levels of Functional Impairment by Group at Low/High Levels of Permissive Parenting

Wade et al, JAMA Peds, 2016
The following are associated with better outcomes after TBI except:

A) Permissive or authoritarian parenting style
B) Positive family functioning
C) Social capital and community engagement
D) Good preinjury child adjustment
TBI: A Perfect Storm?

- TBI increases the likelihood of learning, executive function, and psychological health problems; may exacerbate pre-existing problems. Greater impact in children from financially and socially disadvantaged backgrounds.

- Problems in identification of needs and medical to education transition; is TBI really a low incidence condition?
  - Physicians often not comfortable completing qualifying paperwork
  - Houston ISD 210K students, 36 (0.2%) receive special education under the qualifying diagnosis of TBI.
  - Children with less severe TBI less likely to be served.

- Schools serve as the primary rehabilitation agent for many children—special education and related services are often under-resourced.

- No monitoring systems in place to track kids with TBI. The longer the time since injury, the less likely cognitive and psychological health problems are linked to TBI; kids are more likely to be viewed as behavior problem.
Care for traumatic brain injury (TBI) is often fragmented or ceases after discharge from acute medical services. For the purposes of monitoring children’s recovery from TBI, a simple but effective screening tool is needed.

We propose the Pediatric Injury Check-Up for Brain Health (PIC-UP) as a new measure that may serve that purpose. Modeled on existing measures of post-concussive symptoms and quality of life, the PIC-UP is designed to be completed by parents, youth, and school personnel, thereby providing the opportunity to elicit multiple perspectives and coordinate care across settings.
At this time, is your child experiencing any of the following difficulties?

Physical problems (e.g., poor balance, dizziness, headache, sleep disturbance) Y/N
Learning or school problems (e.g., problems remembering, mental slowing, organizational difficulties, difficulties following directions, poor school attendance, poor grades) Y/N
Emotional problems (e.g., sadness, worry, anxiety, anger, irritability) Y/N
Attention or behavioral issues (e.g., difficulty sitting still, inattention, aggressive behavior, behavioral outbursts, disruptive behavior, school suspension) Y/N
Social problems (e.g., social withdrawal, difficulties making or keeping friendships, rejection or victimization by other children) Y/N

If you answered NO to all of these questions, you are done with the survey.

If you answered YES to any of the questions, please answer the next two questions:

Is your child receiving help for any difficulties you report above? Y/N
If yes, do you feel the help is meeting your child’s needs? Y/N

*If you answered NO to question 6 or 7, you should discuss your child’s difficulties with your child’s healthcare provider and school.
Resilience Factors: Buffers Against Adversity

- Positive physical development
- Academic achievement/intellectual development
- High self-esteem
- Emotional self-regulation
- Good coping skills and problem-solving skills
- Engagement and connections in two or more of the following contexts: school, with peers, in athletics, employment, religion, culture
- Relationship with caring adult
Resilience Factors: Buffers Against Adversity

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- Engagement and connections in two or more of the following contexts: school, with peers, in athletics, employment, religion, culture
- Relationship with caring adult
Promoting Resilience in TBI

- Track kids from hospital through school and developmental transitions to maintain/increase services as needed

- Promote academic skill development through individualized instruction targeting common weaknesses in executive functions, learning efficiency, and processing speed

- Offer targeted interventions--Wade et al’s online teen and family problem solving programs

- Counseling services to enhance self-regulation and adjustment

- Build social capital--provide social skills intervention and friendship promoting activities, assist children to engage in extracurricular activities

- Provide/refer for family interventions to promote positive parenting

- Be the supportive adult in a struggling child’s life
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