

# Cognitive Assessment After Pediatric Traumatic Brain Injury (TBI): Inpatient to Outpatient Follow-up

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# Disclosures

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Christine Petranovich and Sarah Tlustos-Carter declare no conflicts of interest

We do not have any financial relationships to disclose

# Agenda

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## **Review of relevant literature**

- Pediatric-specific considerations
- Inpatient rehabilitation cognitive assessment

## **TBI services at CHCO**

- The value of a team approach
- Neurotrauma Unit
- Acquired Brain Injury (ABI) Clinic

## **Associations of inpatient factors with 1-year outcomes**

## **Case example**

## **Conclusions**

# Pediatric-Specific Considerations

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Compared to adults – children’s brains still developing!

- More likely to have diffuse injuries and certain secondary complications, such as seizures

Diffuse damage may interrupt cerebral development

- Development of white and gray matter
- Abnormal circuitry results
- Young children have few ‘developed’ skills: less to “recover”
- Can interfere with future skill acquisition

# Pediatric-Specific Considerations

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Prognosis improves as age of injury *increases*

- Can't 'recover' what was never there in the first place!
- Late-emerging deficits: *Growing into lesions*

Must also consider the *contextual demands*

- Demands of school: Continual demands to acquire new information
- What is the child being asked to do and when being asked to do it?

# Functional Impact in Children: Education

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Greater deficits in arithmetic than reading

Reading comprehension, written expression may be affected by other deficits (EF)

Standardized tests of academic achievement

- Significant differences not always apparent
- Adequate achievement scores in many cases
- Typical “LD” pattern not seen

# Functional Impact in Children: Education

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Yet, clear educational (and vocational) problems

- Poor classroom performance
- Increased need for special education services
- Drop out of school early
- Trouble finding competitive employment

# Starting Early: Inpatient Assessment

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# Inpatient Cognitive Assessment

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- Limited adult research
  - Verbal memory and executive functioning associated with activities of daily living (Hanks, Jackson, & Crisanti, 2016; Hanks et al., 1999; Hanks et al., 2008)
  - Injury-related factors: GCS, Functional Independence Measure (FIM), and length of inpatient stay (Sandhaug et al., 2010)
- Literature even more sparse in children
  - Time to follow commands and time from injury to rehab admission predict functional status (Kramer et al., 2013)

# Cognitive and Linguistic Scale (CALs)

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- Developed by Beth Slomine, Ph.D. & Janine Spezio Eikenberg, M.S., CCC-SLP at Kennedy Krieger Institute
  - Children and teens age 2-19
  - Items range from basic responding to higher-level cognitive skills to be used across continuum of recovery
    - Structured observations + task performance
  - Good interrater reliability and internal consistency (Slomine et al., 2008)
- 20 items, rated 1-5 (total scores range from 20-100)
  - Significant change from admission to discharge
  - CALs is highly correlated with the WeeFIM, although potentially more sensitive as improvement was shown on the CALs even in patients with limited/ no change on the WeeFIM

# TBI Services at CHCO and the Role of Neuropsychology

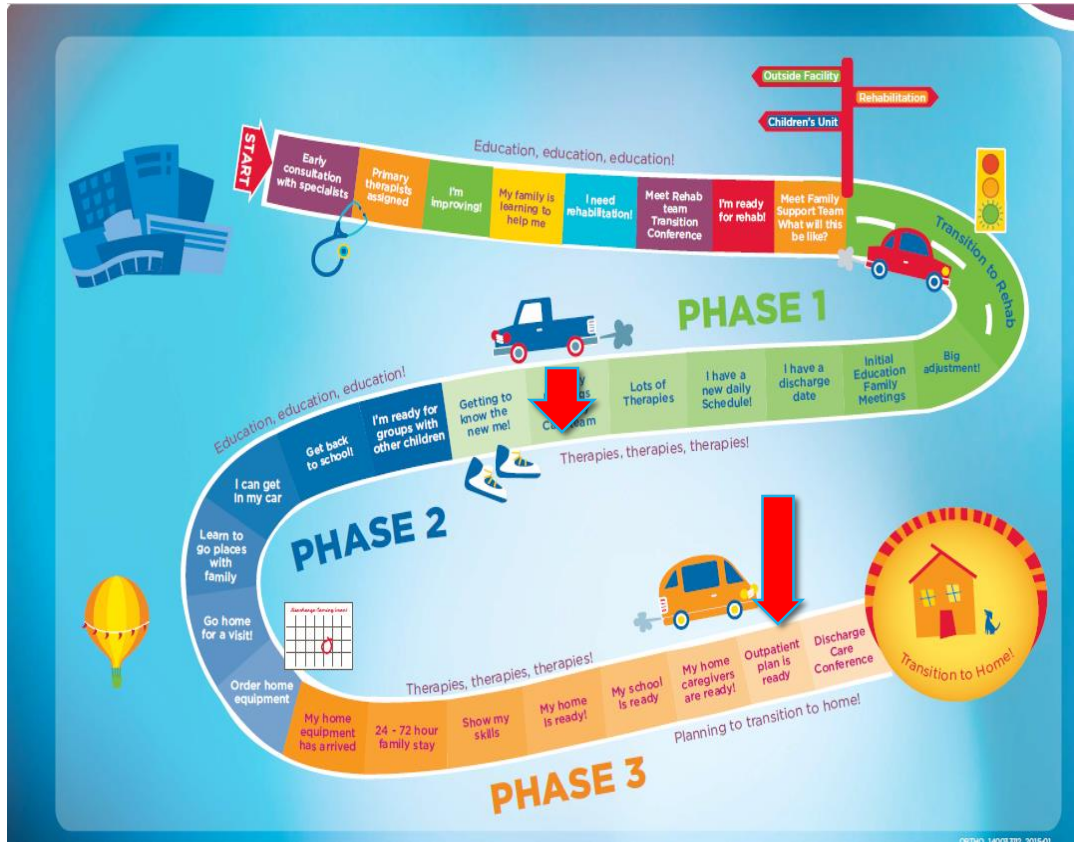
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# Value of Teamwork

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- More than 80 randomized controlled trials have shown collaborative care to be more effective than usual care for common mental health conditions
- Results in more effective communication among providers
- Can increase initial costs, but reduces total medical expenditures in the long-run (Serrano, 2014)
  - Although this evidence is mixed (Ke et al., 2013; Kubu, 2016)

# CHCO Rehab Process: A Team Approach



- Family and staff meetings of entire team
- Phases help guide progress toward discharge
- Return to school built in.
- Factors considered:
  1. Medical stability
  2. Fatigue
  3. Behavior
  4. Level of support required

# What neuropsychology brings to a team

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- Understanding of brain-based influences on behavioral and emotional presentations
- Objective information about current functioning
- Highlights risks and protective factors
- Integration to school and community
- Ability to track recovery of function over time
- Can be therapeutic to patients and their families

# CHCO Inpatient Neuropsychology Service

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## *Acute recovery phase*

### Serial assessments

- Baseline, progress monitoring
- “recovery” vs. response to intervention

### Single point assessments

- Developing initial treatment goals
- Understanding strengths and weaknesses
- Integrated case formulation
- Informs needed adaptations to traditional treatment approaches

# Inpatient Cognitive Monitoring

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- Initial assessment
  - Orientation, Emergence from Post-traumatic Amnesia (PTA)
  - Mental Status (basic screening of language, visual-spatial, basic attention, immediate memory)
  - Cognitive and Linguistic Scale (CALs)
    - Arousal, responsivity, emotional regulation, inhibition, focusing, response time, orientation, new learning, simple / complex receptive language, simple / complex expressive language, initiation, pragmatics, simple / complex planning & problem-solving, visuoperceptual, visual spatial abilities, self-monitoring, “safety”
  - Other, as indicated
- Serial monitoring: Repeat CALs every 1-2 weeks and prior to discharge



# Discharge Assessment

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- Complete abbreviated neuropsychological battery (~1.5-2 hours)
- Purpose is to inform transition back to home and school
- Reintegration
  - Need specialized educational program or supports?
  - Need specific home-based supports (structure / routines)?
  - Inform cognitive abilities for ongoing therapies
  - How will current abilities impact participation in psychological therapies or response to behavioral management?
- Still recovering. Abilities expected to change throughout recovery and development

# Neuropsychological Assessment

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## Domains Assessed:

- Intellectual capacity
- Sensory-Motor
- Language
- Visual-Spatial
- Memory
- Attention
- Processing Speed
- Executive Functions
- Emotional Functioning
- Social Functioning
- Academics – Pre-injury estimate

# Rehab Discharge Checklist

Hyperspace - Children's Hospital Colorado - Production - REHABILITATION CLINIC - JODI C KRAUSE

Ask a Specialist | Sched w/ Pt List | Chart | Telephone Call | Patient Station | Calculator | Remind Me | Appts

Workbench

### SmartText Editor - REHAB DISCHARGE SCHOOL [35122]

Name: REHAB DISCHARGE SCHOOL | Version: 10/30/2017 | Log events?

General | Restrictions | Discrete Data Settings | Editors List | Used By | Synonyms | Languages & Overrides

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To Whom It May Concern,

Your student has had an injury or illness resulting in an inpatient rehabilitation stay at the Children's Hospital of Colorado. In order to foster a smooth and successful school transition, the following services and accommodations are suggested by the inpatient rehabilitation team. We recommend consideration of the following:

Recommended Special Programming:  
{504 or IEP:23264}

\_\_\_\_ Your district has an established BrainSteps Team. They are a resource to you on brain injury education and brain injury in the school setting. We recommend you work closely with this team for the return to school transition.

Therapies Recommended in the School Setting:  
{school setting tx:44494}

Medical:

- {school:44495}

For safety your student will require adult supervision

- {Rehab School Safety Recs:44504}

Mobility/Gross Motor  
Your student requires a {Rehab Assistive Mobility Recs:37722}

- {Rehab Device Frequency:32738}

During transitions allow for

Insert SmartList

Connection logic in this SmartText:

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+ Add to SmartText

Override SmartList Defaults

Additional Notes

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# CHCO Acquired Brain Injury (ABI) Clinic

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- Goal: long-term, multidisciplinary follow-up care after acquired brain injuries
- The team:
  - Speech/ language therapy
  - Occupational therapy
  - Physical therapy
  - Rehabilitation medicine and nursing
  - Rehabilitation psychology and neuropsychology
  - School/ education coordination
  - Social work

# ABI Clinic

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Cognitive Recovery on a continuum....



CO Brain Injury Steering Committee: Adapted from Miller, 2007; Reitan and Wolfson, 2004; Hale and Fiorello, 2004

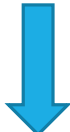
# CHCO Follow-up care after TBI

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Inpatient



1 month: Emotion inventory and review discharge testing



3 months: Academic screening



6 months: Screening focused on attention, speed, and memory



12 months: Comprehensive evaluation

# Comprehensive Neuropsychological Assessment: Cognitive measures

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- Typically 5-6 hours of cognitive testing
- Based on the patient's history, injury characteristics, and current concerns
- A core battery based on the Common Outcomes Measures in Pediatric TBI (McCauley et al., 2012)
  - IQ
  - Academic skills
  - Attention
  - Processing speed
  - Executive functions, both performance-based and standardized report
  - Fine motor
  - Memory
  - Behavior and emotional functioning
  - Quality of life

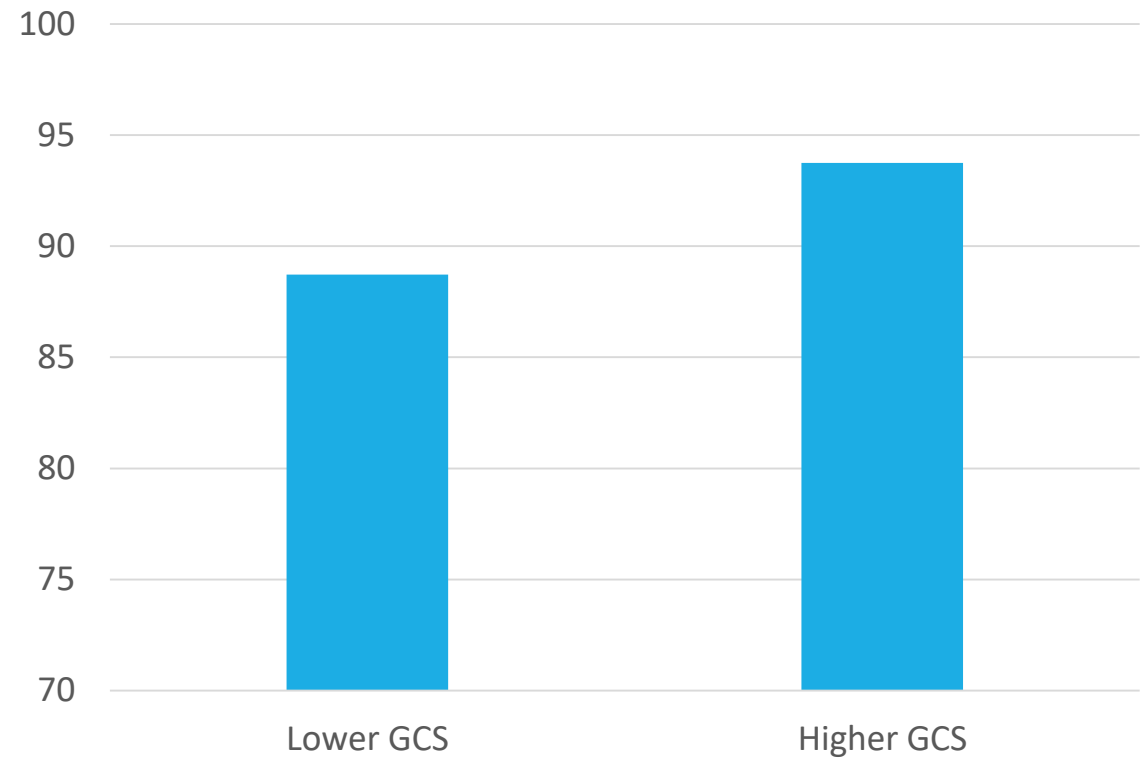
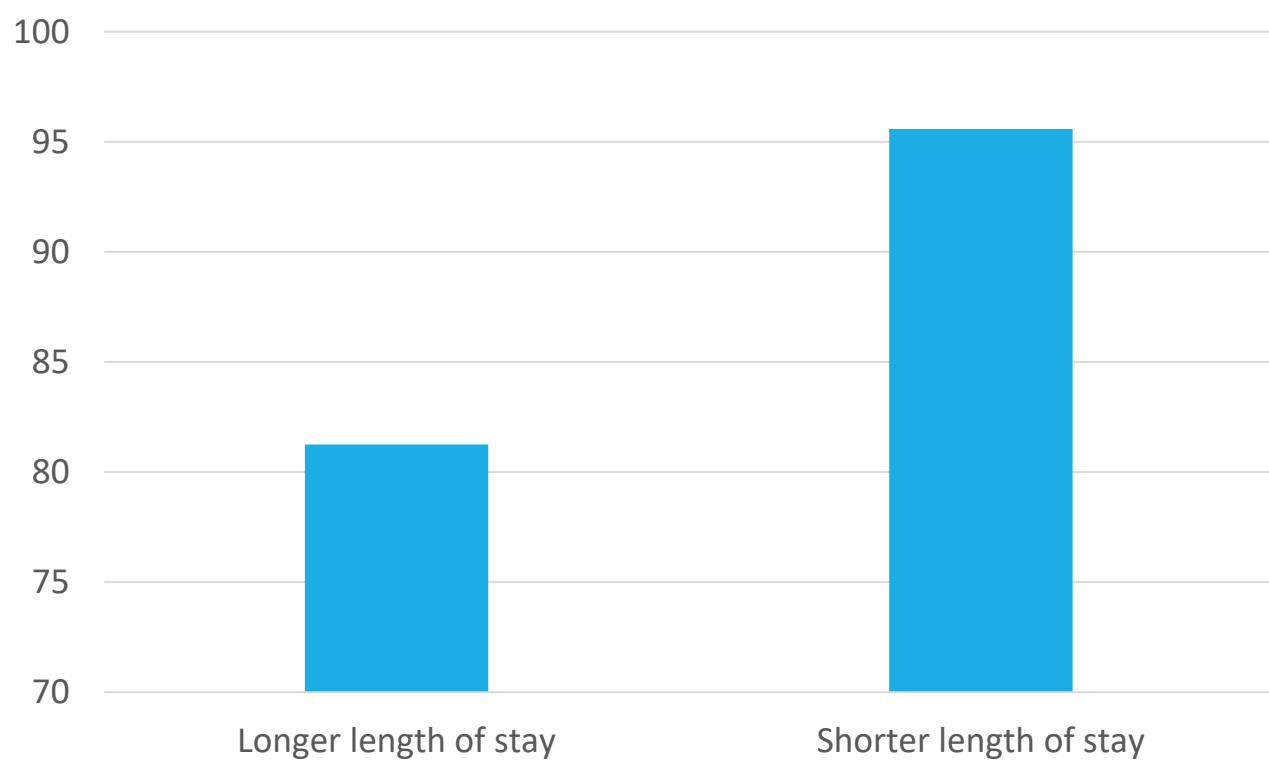
# Outcomes after inpatient rehabilitation: Preliminary findings

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	Full-Scale IQ		BASC Adaptive Functioning	
	<i>Unstd <math>\beta</math> (SE)</i>	<i>t (p)</i>	<i>Unstd <math>\beta</math> (SE)</i>	<i>t (p)</i>
Length of stay	-.40 (.12)	-3.20 (.01)*	-.20 (.22)	-.09 (.93)
Lowest GCS	-2.10 (.96)	-2.19 (.06)	-1.84 (1.15)	-1.16 (.29)
Initial CALS	.24 (.11)	2.07 (.07)	.12 (.18)	.65 (.54)



## Full Scale IQ score



# Case Example

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- Previously healthy, right-handed male
- No preexisting developmental, cognitive, or learning problems
- Some pre-injury conduct and behavioral issues that likely contributed to the circumstances around the injury
- 14 years old at the time of injury
  - TBI resulting from an assault
  - GCS = 7 upon arrival to the hospital, reflecting that it was a severe injury
  - CT: mild asymmetry in the prominence of cerebral sulci greater on the left than the right. There is slightly prominent pretemporal subarachnoid space on the left compared to the right
  - Seizures

# Case Example: Inpatient Data

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- Inpatient CALS showed expressive language, attention, and organization
  - Story formulation: tangential, run-on sentences, poorly organized
  - Difficulty with problem-solving, identifying steps to complete a complex task
  - Fairly good insight, but often off-topic and easily frustrated by challenge

# Case Example: Discharge Testing

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- Discharge testing:
  - Average overall IQ, **slightly weaker verbal** (low average) than nonverbal (average)
  - Average single-word reading and brief attention/ working memory
  - Severely impaired to low average **processing speed**
  - Executive functions: Planning average, verbal fluency average for categories and mildly impaired for letters, **cognitive set shifting** mildly impaired
  - Verbal and visual learning and memory: **immediate and delayed impaired**, recognition intact
  - **Fine motor skills** impaired bilaterally

# Case Example: ABI Follow-Up

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- Healthy since the injury
  - Outpatient physical and occupational therapies after discharge
- Word finding most notable concern
- Mild concerns about organization, attention, and distractibility
- Per mother, “speaks his mind, but isn’t aware that he may be rude or disrespectful”
  - Briefly received mental health therapy 2x after the TBI
- Fatigue and poor sleep
- IEP implemented after the TBI
  - Accommodations in general education setting
  - Difficulty making up missed credits
  - Teacher concerns about missing assignments and not participating in class

# Case Example: ABI Follow-Up

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- Affect mostly neutral, friendly and socially engaged
- Notable frustration on challenging tasks (““I will walk out of here””)
- Word finding problems (“I can’t think of what it’s called”)
- Attention and activity level normal

# Case Example: ABI Follow-Up

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- Low average overall intellectual ability
- Expressive language, visual-spatial skills, attention/ working memory, and fine motor coordination broadly normal
- Processing speed ranged from mildly impaired to average
- Memory:
  - Impaired immediate and delayed recalls on verbal memory, average recognition
  - Low average immediate and delayed recalls on visual memory, impaired recognition
- Executive functions:
  - Mildly impaired cognitive flexibility and inhibition
  - Variable verbal fluency
  - Mother denied concerns on standardized rating

# Case Example: Conclusions

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- Multiple improvements, most notably fine motor coordination
- Areas of weakness were consistent across evaluations
  - CALS seemed to pick up executive/ organizational weaknesses early in the course of recovery
  - Executive functions, processing speed, and memory improved, but persisted as areas of weakness across evaluations
- Pre-injury history + TBI places him at risk for behavior and emotional difficulties moving forward
- Will likely require moderate accommodations in school and in jobs settings
- Recommended another neuropsychological follow-up in 1-2 years to continue to monitor progress



# Conclusions and Future Directions

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# Conclusions

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- Nationally, there is greater interest in early assessment to help guide treatment
- A collaborative approach that includes cognitive assessment is valuable for patients
- Early cognitive assessment may help to better predict longer-term outcome

# Program Goals

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- Establish standards for inpatient cognitive assessment for rehabilitation
- Better understand the relationships of inpatient factors with 1-year outcome
- Within our program, increase consistency in measures and procedures
- Better support transition from hospital to home

Thank you!

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