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Kids Rehabilitation Hospital

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Exploring the King's Outcome Scale for Childhood Head Injury in Children Attending a Rehabilitation Hospital

Peter Rumney¹ MD; Ryan Hung¹ MD; Laura McAdam¹ MD; Arthur Ameis² MD; Michel Lacerte³ MD; Pierre Cote⁴ Ph.D; David Cassidy⁵ Ph.D; Eleanor Boyle⁵ Ph.D; Dayna Greenspoon¹ MSc(OT)

Holland Bloorview Kids Rehabilitation Hospital¹, University de Montreal², Western University³, University of Ontario Institute of Technology⁴, University Health Network

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Background: Reason for Outcome Measures

- **Traumatic Brain Injuries (TBI):**

- Common cause of future disability in children (Sharples, 1998)
- Risk for lifelong cognitive, behavioural and physical impairments (Thomas-Stonell, Johnston, Rumney, et al., 2006)

Important to:

- Evaluate effectiveness of treatment programs
- Determine level of disability in children so appropriate resources can be available to provide support (Government and Third Party)

Clinicians need a **reliable** and **valid** method of measuring **disability** after pediatric brain injury



Background: Outcome Measurement Considerations in Pediatrics

- Outcome measurement in pediatric brain injury:
 - Must be cognizant of ongoing neurodevelopmental changes in the brain
 - Questions and response categories must be age appropriate
 - Functional Activities should be the focus of assessment as opposed to evaluation of dysfunction, physical impairment alone



King's Outcome Scale for Childhood Head Injury (KOSCHI)

- Developed by Crouchman and colleagues (2001)
- Adaptation of the Glasgow Outcome Scale
- Target:

" to provide a robust, simple description of outcome after pediatric TBI in the short, medium or long term" (Crouchman, Rossiter, Colaco, & Forsyth, 2001, p. 120)



Comparison with the Glasgow Outcome Scale and its Variants

Score	Grade	Explanation
1	Good recovery	Returned to the original functional level and employment with no deficit.
2	Moderate disability	Minor neurological deficit that does not interfere with daily functioning or work
3	Severe disability	Significant neurological deficit that interferes with daily activities or prevents return to employment
4	Vegetative	Coma or severe deficit rendering the patients totally dependant
5	Death	Self explained

Jennett & Teasdale : Management of Head Injuries 1981 pg. 306

Glasgow Outcome Scale Extended

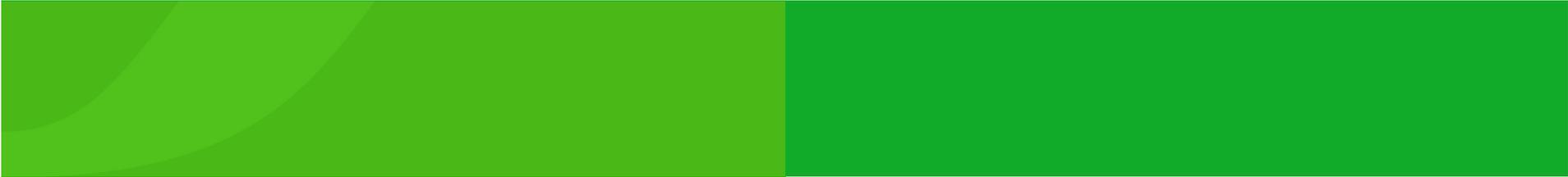
1	Death	D
2	Vegetative state	VS
3	Lower severe disability	SD -
4	Upper severe disability	SD +
5	Lower moderate disability	MD -
6	Upper moderate disability	MD +
7	Lower good recovery	GR -
8	Upper good recovery	GR +

[February | 2015 | Peripheral Brainbrainmd.wordpress.com](http://Peripheral Brainbrainmd.wordpress.com)
MODIFIED RANKIN SCALE (MRS)

Pediatric GOS-E

Beers, Wisniewski et al – J.of Neurotrauma 29:1126-1139
(Apr. 2012)

- 1) Consciousness No (Veg State) /Yes -> 2
- 2) Independence in the Home No /Yes -> 3
 - Activities of Daily Living
 - *Need for frequent help from Caregiver*
 - **No/Yes (Lower Severe Dis/ Upper Severe Disability)**
- 3) Independence Outside of the Home No/Yes ->4
 - Ability to shop and travel without assistance
 - *Behave age appropriately outside of the home* **No/Yes -> 4**
 - **(Upper Severe Disability)**
- 4) School/Work – Can the child Fx in school/work at previous capacity No/Yes ->5
 - Reduced work or school capacity **No/Yes (Lower Mod/Upper Mod. Disability)**
 - Able to work only in sheltered workshop or school for severely impaired children

- 
- 5) Social & Leisure Activities: Child able to resume regular Social/School Activities No/Yes -> 6
 - What extent of restrictions on social/leisure Activity
 - *Rarely or Unable to Participate (Lower Mod. Disability)*
 - *Participates Much less often < 50% (Upper Mod. Disability)*
 - *Participates somewhat less often > 50% (Lower Good Recovery)*
 - 6) Family & Friendships – Are there psychologic problems that result in disruption No/Yes -> 7
 - Constant Disruptions – Daily (Lower Mod. Disability)
 - Frequent – Weekly or more (Upper Mod. Disability)
 - Occasional – Less than Weekly (Lower Good Recovery)
 - 7) Return to Normal Life No/Yes (Lower/Upper Good Recovery)

KOSCHI

Table 1. KOSCHI category definitions. Taken from: Paget., S.P., Beath, A.W.J, Barnes, E.H., & Waugh, M.C. (2012). Use of the King's Outcome Scale for Childhood Head Injury in the Evaluation of Outcome in Childhood Traumatic Brain Injury. *Developmental Neurorehabilitation, 15(3)*, 171-177.

Table I. KOSCHI category definitions (4).

KOSCHI category	Definition
1. Death	
2. Vegetative	The child is breathing spontaneously and may have sleep/wake cycles. He may have non-purposeful or reflex movements of limbs or eyes. There is no evidence of ability to communicate verbally or non-verbally or to respond to commands.
3. Severe disability	<p>(a) The child is at least intermittently able to move part of the body/eyes to command or make purposeful spontaneous movements; for example, confused child pulling at nasogastric tube, lashing out at carers, rolling over in bed. May be fully conscious and able to communicate but not yet able to carry out any self care activities such as feeding.</p> <p>(b) Implies a continuing high level of dependency, but the child can assist in daily activities; for example, can feed self or walk with assistance or help to place items of clothing. Such a child is fully conscious but may still have a degree of post-traumatic amnesia.</p>
4. Moderate disability	<p>(a) The child is mostly independent but needs a degree of supervision/actual help for physical or behavioural problems. Such a child has overt problems; for example, 12 year old with moderate hemiplegia and dyspraxia insecure on stairs or needing help with dressing.</p> <p>(b) The child is age appropriately independent but has residual problems with learning/behaviour or neurological sequelae affecting function. He probably should have special needs assistance but his special needs may not have been recognised/met. Children with symptoms of post-traumatic stress are likely to fall into this category.</p>
5. Good recovery	<p>(a) This should only be assigned if the head injury has resulted in a new condition which does not interfere with the child's well being and/or functioning; for example:</p> <ul style="list-style-type: none"> • Minor headaches not interfering with social or school functioning • Abnormalities on brain scan without any detectable new problem • Prophylactic anticonvulsants in the absence of clinical seizures • Unsightly scarring of face/head likely to need cosmetic surgery at some stage • Mild neurological asymmetry but no evidence of affect on function of limb. Includes isolated change in hand dominance in young child. <p>(b) Implies that the information available is that the child has made a complete recovery with no detectable sequelae from the head injury.</p>

KOSCHI- What does the literature say?



Limited data on its psychometric properties (Crouchman et al., 2001; Hawley et al., 2003; Calvert et al. 2008; Shashikiran et al., 2012)

- Retrospective chart review methodology
- Moderate reliability (inter-rater)- kappa ~0.51
- Variable convergent validity with quality of life and cognition measures when used as a one-time measure

Paget, Beath, Barnes, & Waugh (2012):

- Moderate to good inter-rater reliability – weighted kappa 0.71
- Longitudinal follow-up:
 - Half -no change in KOSCHI score
 - Younger than 8 years of age (at time of injury): scores worsened over time in 23% of cases
 - Older than 8 years: no scores worsened over time

KOSCHI- What does the literature say?



Casselden, Kirkham, & Durnford (2014)- Abstract

Examined inter-rater reliability of Glasgow Outcome Scale Extended-Peds (GOS-E) and KOSCHI

- GOS-E Peds: Poor agreement ($k=0.19$) at discharge, fair agreement ($k=0.47$) at follow-up
- KOSCHI: Fair agreement at discharge ($k=0.26$) and follow-up ($k=0.31$)
 - Combining subcategories of major outcome groups for KOSCHI: inter-rater reliability ↑

Research Objectives:

To examine:

- 1) The inter-rater and intra-rater reliability of the KOSCHI among children attending a rehabilitation hospital with acquired brain injuries
- 2) Compare KOSCHI with other validated measures of overall health status (MPAI and PedsQL)
- 3) The responsiveness of the KOSCHI

Participants: Inclusion and Exclusion



Inclusion:

1. Youth between the ages of 4 to 18 years
2. English speaking families
3. Diagnosed with an acquired brain injury

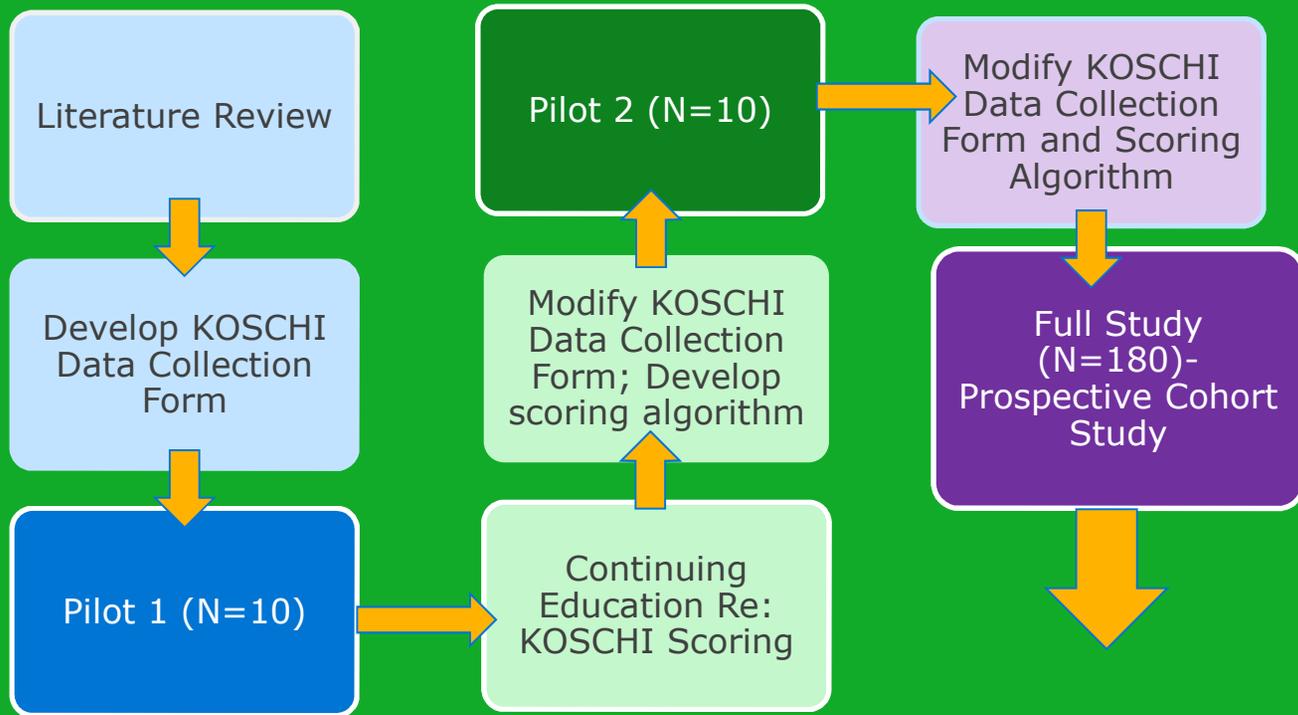
Exclusion:



- Children diagnosed with an acquired brain injury as a result of:
 - surgical complications for the treatment of epilepsy
 - have any developmental disorders
 - have progressive inflammatory encephalopathy

A total of 200 youth were recruited from a post-acute inpatient pediatric rehabilitation facility with long-term follow-up

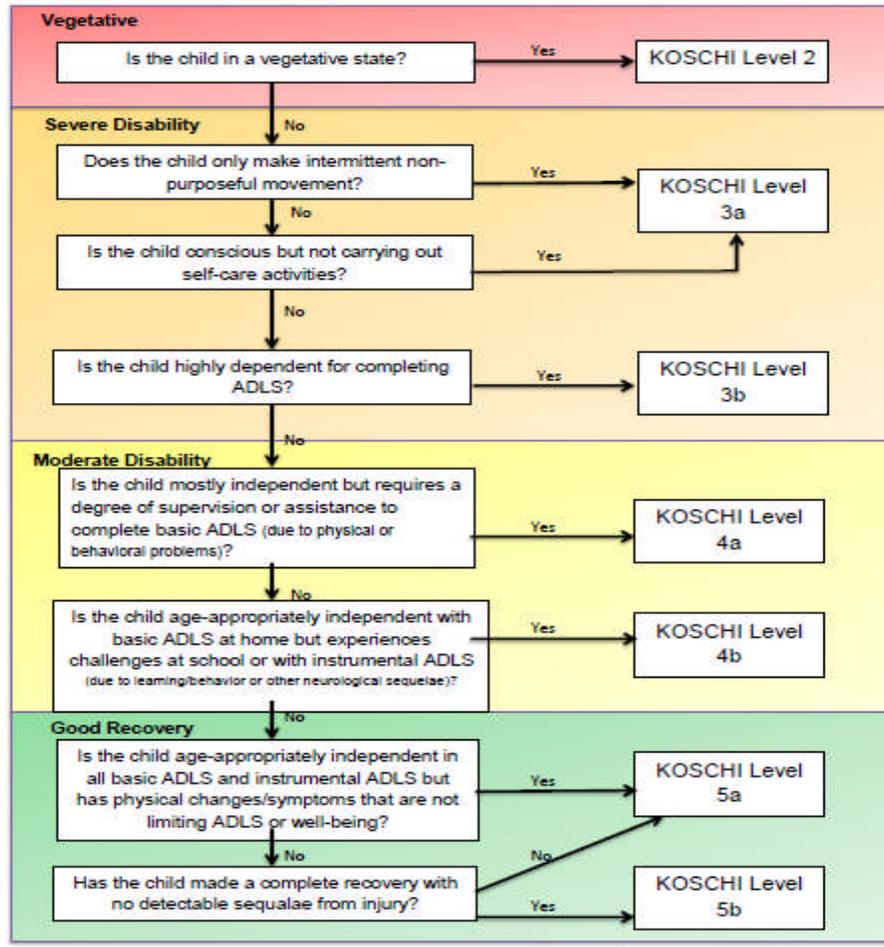
Method: Pilot Studies



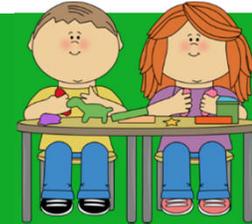
KOSCHI Scoring Algorithm:

KOSCHI Algorithm for Scoring

Reminder: Scoring based on neurologic impairments/ injuries only



Other Health Outcome Measures



**Mayo- Portland Adaptability Inventory (MPAI)
(Pediatric Adaptation)** (Malec et al., 2003)

The Pediatric Quality of Life Scale (PedsQL)

(Varni et al., 1999)

Methods: Full Study

Inpatient/Day patient Baseline

- A pediatrician completes:
 - in-person ax & KOSCHI data collection form
 - KOSCHI Score
 - MPAI
- Family completes PedsQL and demographic form
- Severity indicators collected
- A second pediatrician scores from data collection form
- Two physiatrists score KOSCHI collection form

Outpatient Baseline

- A pediatrician completes:
 - in-person ax & KOSCHI data collection form
 - KOSCHI Score
 - MPAI
- Family completes PedsQL and demographic form
- Scores collected
- score KOSCHI from data



Scoring is blinded

Intra-Rater Reliability
(random sample)

- A pediatrician completes:
 - in-person ax & KOSCHI data collection form
 - KOSCHI Score
 - MPAI
- Family completes PedsQL and demographic form

Results: Demographics

		Frequency
Gender	Male	130
	Female	70
Type of Injury	Traumatic	104
	Mild	24
	Moderate	22
	Severe	58
	Non-Traumatic	96

Table 1. Gender and Injury Type

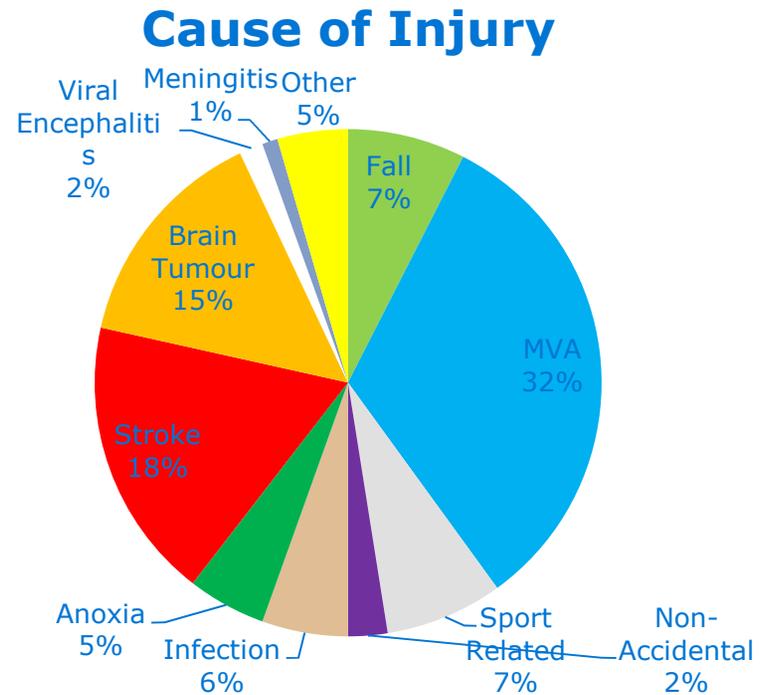


Figure 1. Cause of Injury

Results: KOSCHI Score Frequency

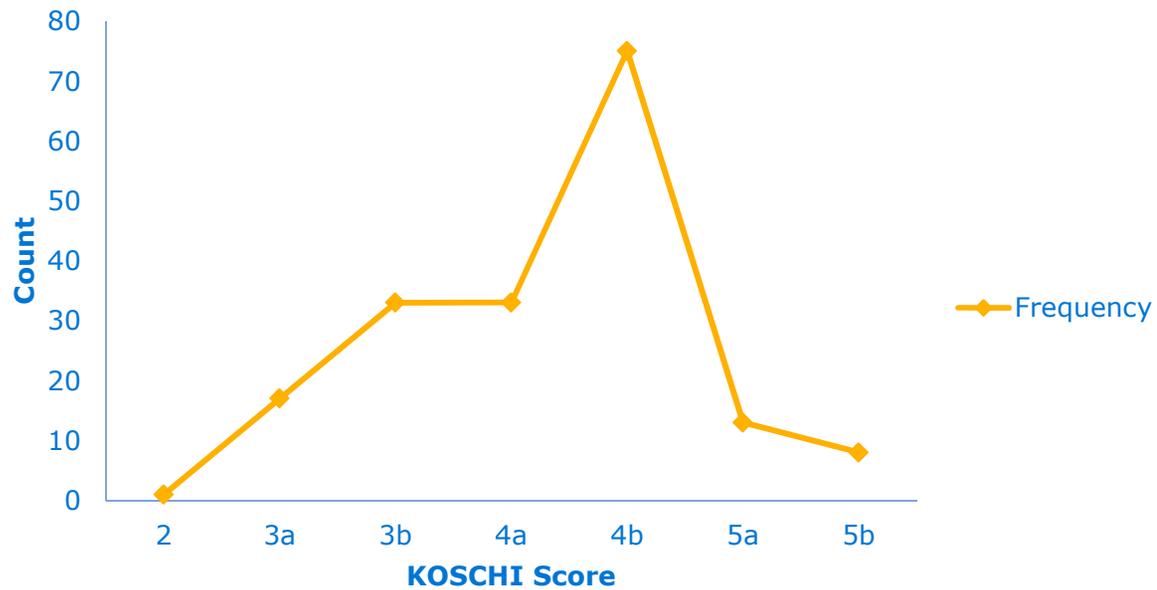


Figure 2. Distribution of in-person KOSCHI scores at baseline by the primary pediatrician (N=180)

Results: Inter-rater Reliability

	Weighted Kappa (95% CI)	Spearman Correlation
Pediatrician to Pediatrician		
In-person Assessment to Chart Review		
Inpatient/Daypatient Baseline	0.54 (0.4-0.67)	0.69
In-person Assessment to Form Derived		
Outpatient Baseline	0.63 (0.53-0.73)	0.82
Outpatient Follow-Up	0.71 (0.51-0.91)	0.83
Inpatient/Daypatient Follow-Up	0.68 (0.51- 0.86)	0.86
Physiatrist to Physiatrist		
Form Derived to Form Derived		
Outpatient Baseline	0.69 (0.59-0.79)	0.85
Outpatient Follow-Up	0.64 (0.48-0.80)	0.83
Inpatient/Daypatient Baseline	0.47 (0.32-0.62)	0.68
Inpatient/Daypatient Follow-Up	0.69 (0.51-0.87)	0.99

Table 3.
Weighted
Kappa's; CI=
Confidence
Interval

Results: Inter-rater Reliability

	Inverse Variance Kappa
Pediatrician to Physiatrist	
In-Person Assessment to Form Derived	
Outpatient Baseline	0.65
Outpatient Follow-Up	0.64
Inpatient/Daypatient Baseline	0.52
Inpatient/Daypatient Follow-Up	0.61
Form Derived to Form Derived	
Outpatient Baseline	0.80
Outpatient Follow-Up	0.88
Inpatient/Daypatient Follow-Up	0.73

Table 4.
Inverse
Variance
Kappa's

Results: Inter-rater Reliability (Scoring Discrepancies)

	2	3a	3b	4a	4b	5a	5b
2	1	0	0	0	0	0	0
3a	0	8	5	0	1	0	0
3b	0	4	15	8	0	0	0
4a	0	0	4	11	2	0	0
4b	0	0	0	3	1	1	0
5a	0	0	0	0	0	0	0
5b	0	0	0	0	0	0	0

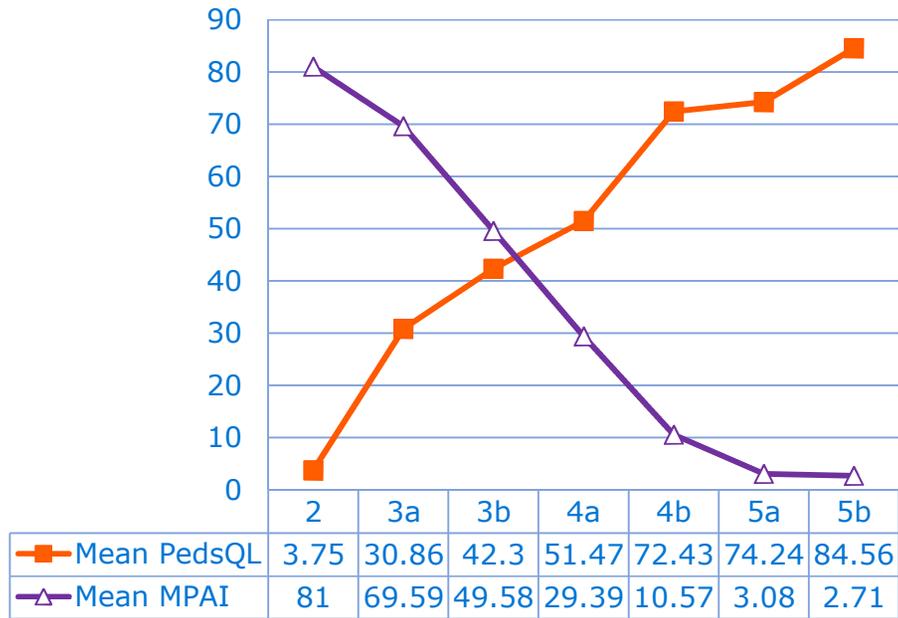
Table 5. Discrepancies in KOSCHI Scores among Pediatricians (Baseline, Inpatient/Daypatient, In-Person to Form Derived); n=64

Results: Intra-Rater

	n	Weighted Kappa (95% CI)	Spearman
Physiatrist 1	16	0.92 (0.78-1.06)	1.00
Physiatrist 2	16	0.81 (0.62-1.01)	0.90
Pediatrician 1	13	0.89 (0.7-1.08)	0.98
Pediatrician 2	12	0.89 (0.67-1.11)	0.92
Pediatrician 3	12	0.69 (0.38-1.00)	0.83

Table 6.
Intra-Rater
Reliability
for
Outpatient
Data

Results: Comparison of KOSCHI to Other Measures of Overall Health Status



Spearman Correlation:

KOSCHI- PedsQL:
0.68

KOSCHI-MPAI:
-0.87

Figure 3. Convergent Validity of KOSCHI

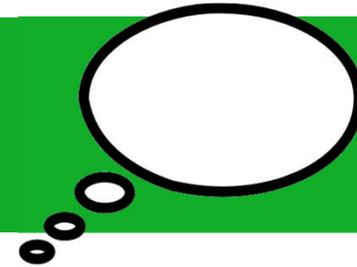
Results: Change in KOSCHI Scores- Baseline to Follow-Up

Follow-Up Duration: 0.85 years (mean); 0.34 (SD)

Baseline KOSCHI Scores	Follow-Up KOSCHI Scores							Totals
	2	3a	3b	4a	4b	5a	5b	
2	0	0	0	0	0	0	0	0
3a	0	2 →	6 →	1 →	1	0	0	10
3b	0	0	3	2	3	1	0	9
4a	0	0	0	3	6	1	0	10
4b	0	0	0	1	14	5	0	20
5a	0	0	0	0	0	0	0	0
5b	0	0	0	0	0	0	1	1

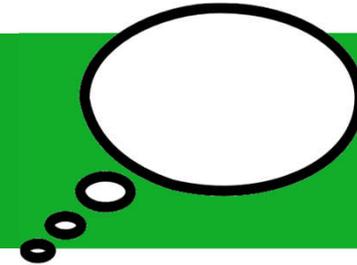
Figure 4. Change in KOSCHI scores over time (N=50)

Discussion



- Agree with previous literature: KOSCHI is easy to score retrospectively from medical records (Crouchman et al., 2001, Calvert et al., 2008, Paget et al., 2012)
 - Easy to score from in-person assessment
- Addition of a KOSCHI data collection form and scoring algorithm did not improve reliability substantially
- Moderate inter-rater reliability (consistent with previous literature) (Crouchman et al., 2001, Calvert et al., 2008, Paget et al., 2012)
- Good intra-rater reliability
- Highest inter- and intra- rater reliability when scoring from data collection form

Discussion



- Previous literature raised concern re: need for clarification of the differences in subcategories
 - Past literature shows improved kappa with collapsing subcategories (e.g., Casselden et al., 2012)
 - But lose sensitivity to important clinical changes
 - Do not need to collapse subcategories to get reasonable inter-rater reliability
- Good correlation with the other overall measures of outcome
 - Correlation with the family’s perceived quality of life (PedsQL) is not as strong as with the physician’s scoring of the functional outcome measure (MPAI)

Limitations and Next Steps



- **Limitations**

- Number of follow-ups
- Inability to have a second in-person rating

- **Next Steps**

- Consider amending the scale
 - Greater clarification of the subcategory differences
 - In higher functioning levels (4b, 5a) factors outside of function influence scoring (e.g., minor headaches, abnormalities on brain scan, scarring)

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Thank you

Contact: prumney@hollandbloorview.ca

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Results: Severity Indicators

	Mean; SD (N)
Age of Initial Ax (years)	12.8; 4.1 (200)
Age at Injury (years)	8.7; 5.5 (200)
Time from Injury to Ax (years)	4.1; 4.6 (200)
Hospital Length of Stay (days)	26.1; 24.839 (160)
ICU Length of Stay (days)	10.1; 11.3 (98)
Ventilation Duration (hours)	201.9; 271.5 (83)
Post Traumatic Amnesia (hours)	220.3; 363.9 (61)
Number of Previous Brain Injuries	2.7; 2.6 (16)
Glasgow Coma Scale	7.7; 3.7 (66)

Table 2a. Severity Indicators (Mean and Standard Deviation)

	Frequency
Previous Brain Injury	
Yes	16
No	182
Do Not Know	2
Surgery for Brain Injury	
Yes	91
No	101
Do Not Know	8
Coma on Admission	
Yes	65
No	135

Table 2b. Severity Indicators (Frequency)