Postconcussion Symptoms as a Marker of Delayed Recovery in Children and Youth Who Recently Sustained a Concussion: A Brief Report

Laurie-Ann Corbin-Berrigan, CAT(C), MSc and Isabelle Gagnon, PhD, pht

Objective: To identify predictors of delayed recovery in children who sustained a concussion and sought care in a pediatric hospital.

Design: Retrospective cohort study design.

Setting: Montreal Children's Hospital Concussion Clinic database.

Patients: Children who sustained a concussion and sought care within 10 days of the injury, with complete medical history and Postconcussion Symptom Scale (PCSS) score available.

Independent Variables: Total symptom score on the PCSS, sex, age, history of concussion, sleep disturbances, anxiety, learning disabilities, attention problems, and depression.

Main Outcome Measure: Delayed recovery (28 days or more).

Results: A total of 213 children (F = 76, M = 138) with a mean age of 13.89 ± 2.55 years were included. Only total PCSS score at 10 days postinjury was identified as a significant predictor of delayed recovery (odds ratio: 1.019, $P = 0.01$).

Conclusions: This study demonstrates the potential for clinicians to identify, with the sole use of the PCSS, children at risk of experiencing symptoms for longer periods of time.

Key Words: concussion, mild traumatic brain injury, children, pediatrics, postconcussion symptoms, delayed recovery, slow to recover

(*Clin J Sport Med* 2016;0:1–3)

INTRODUCTION

Clinicians working with the pediatric concussed population rely mostly on symptom resolution to ascertain recovery postinjury, as advocated by current expert consensus on the management of concussions.[1] Rest is the primary treatment strategy for concussion in the acute phase of recovery; the literature suggests that children and adolescents should abstain from physical and cognitive activities until complete symptom resolution.[1] This strategy works for most children with many of them recovering in the first month.[2] However, 10% to 20% of children and adolescents sustaining a concussion will experience symptoms beyond 4 weeks (28 days),[1,3] classifying them as being *slow to recover or suffering from postconcussion syndrome as per ICD-10 diagnostic criteria*.[4] Delayed or slow recovery affects participation in everyday activities such as school and sports. There is an increasing need for clinicians to identify children at risk of requiring more health care intervention for their atypical recovery, with approaches such as active rehabilitation.[1]

The current literature focuses on prediction of recovery from reported symptoms experienced at the time of injury.[5–7] Other reports suggest that the majority of mild head injury cases are not immediately reported to health care professionals,[8] causing children to seek medical care days after the injury, when initial symptoms cannot easily be recalled, in settings such as hospital-based concussion rehabilitation programs.

The identification of markers of delayed recovery could help guide clinicians in choosing appropriate rehabilitation strategies, as early as their initial consultation with this population. The aim of this study was to identify predictors of delayed recovery in children and youth who sustained a concussion and sought care in a pediatric, hospital-based, concussion clinic.

METHODS

A retrospective cohort study design, based on the Montreal Children's Hospital Concussion Clinic database, was used. This clinic mainly offers services to physically active children (aged 5–18 years), wishing to obtain clearance to return to activities or begin a rehabilitation program for their persisting symptoms.

Participants were included if they had sustained a concussion, as per World Health Organization's definition,[9] and were seen by professionals of the Concussion Clinic between April 1, 2012, and March 31, 2013. Participants whose Postconcussion Symptom Scale (PCSS) score was obtained within 10 days of the injury (initial visit to clinic), and who had a complete medical history, were included. Total symptom score on the PCSS, sex, age, history of concussion, sleep disturbances, anxiety, learning disabilities, attention problems, and depression was used to find the best predictive model of delayed recovery.

Total PCSS was gathered from the Sport Concussion Assessment Tool 2 symptom evaluation.[10] This symptom

evaluation checklist assesses the presence and severity of 22 common symptoms on a scale of 0 (none) to 6 (severe).

Children were identified with delayed or slow recovery if they experienced symptoms for more than 28 days while being followed at Concussion Clinic, whereas symptom-free children as per clinical assessment and discharged from the clinic in less than 28 days postinjury were identified as normal recovery. Children were continuously seen at the concussion clinic until either discharged to return to activities, referred to other health care professional, or voluntarily dropped out of the clinic's program. Ethical approval was obtained from the Montreal Children's Hospital Research Ethics Board.

Statistical Analyses

Binary logistic regression was used to identify markers (PCSS, sex, age, history of concussion, sleep disturbances, anxiety, learning disabilities, attention problems, and depression) of delayed recovery in children who had recently sustained a concussion, with a significance level set at <0.05. Ad hoc analyses were performed on each category of the PCSS (physical, cognitive, emotional, and sleep). Because of the uneven amount of symptoms per category, data analysis included percentage of total possible score with respect to each category. Ad hoc analyses were also performed to assess prediction abilities of individual postconcussion symptoms.

RESULTS

A total of 213 children (F = 76, M = 138) with a mean age of 13.89 ± 2.55 years were included (Table 1). Of the

total, 113 participants met the criteria for delayed recovery. Study groups demonstrated no significant differences regarding age, sex, number of days postinjury, history of sleep disorder, anxiety, depression, learning and attention problems, and number of previous concussions.

Total PCSS score at 10 days postinjury was identified as a significant predictor of delayed recovery (odds ratio (OR): 1.019, $P = 0.01$) (Table 2). Postconcussion symptoms were separated into 4 major categories (physical, cognitive, emotional, and sleep disturbances) which were separately analyzed. The *Emotional* category showed a strong tendency toward significance for predicting delayed recovery (OR: 7.287, $P = 0.05$), when looking at percentage of total score for this category. In addition, when looking at individual symptoms, *Irritability* demonstrated a tendency ($P = 0.07$) when predicting slow recovery.

DISCUSSION

This study demonstrates the potential for clinicians to identify, with the use of the PCSS, children at risk of experiencing symptoms for longer periods of time after a concussion. Indeed, self-reported symptoms (PCSS total

TABLE 1. Patients' Characteristics and PCSS Score at Initial Visit Presented for Overall Group and Subgroups (Slow vs Normal Recovery)

	Overall	Slow Recovery	Normal Recovery
N	213	100	113
Sex			
Male	137 (64%)	66	71
Female	76 (36%)	47	29
Age	13.89 ± 2.55	14.11 ± 2.48	13.64 ± 2.64
Days after injury	5.54 ± 2.52	5.67 ± 2.48	5.44 ± 2.54
No. previous concussions	0.63 ± 0.81	0.67 ± 0.78	0.57 ± 0.83
Concussion Hx	101 (47%)	58	43
Sleep disorder Hx	32 (15%)	18	14
Anxiety disorder Hx	46 (22%)	25	21
Depression Hx	5 (2%)	2	3
Learning disability Hx	10 (15%)	4	6
Attention problems Hx	16 (18%)	10	6
PCSS total*	26.80 ± 19.92	30.14 ± 19.72	23.09 ± 19.67
PCSS % physical	22.65 ± 16.31	25.05 ± 16.29	20.06 ± 16.03
PCSS % cognitive	21.57 ± 19.80	23.70 ± 19.74	19.08 ± 19.76
PCSS % emotional*	13.03 ± 18.63	15.97 ± 20.44	9.83 ± 15.88
PCSS % sleep	18.07 ± 26.45	17.99 ± 24.92	18.33 ± 28.28

*Where significant ($P < 0.05$) independent t test differences were found between slow and normal recovery subgroups.
Hx, History.

TABLE 2. Odds Ratio for Prediction of Slow Recovery Based on PCSS Score and Its Associated Categories

Category	Symptom	OR	Significance
Physical		11.93	0.13
	Headache	0.90	0.46
	Pressure in head	1.13	0.45
	Neck pain	1.08	0.50
	Nausea	0.98	0.88
	Dizziness	0.83	0.19
	Blurred vision	1.17	0.40
	Balance difficulty	1.13	0.46
	Sensitivity to light	0.97	0.82
	Sensitivity to noise	1.18	0.25
Cognitive		0.44	0.53
	Feeling slowed down	1.04	0.81
	Feeling in a fog	0.98	0.93
	Do not feel right	0.93	0.64
	Difficulty concentrating	0.99	0.94
	Difficulty remembering	1.08	0.62
	Fatigue	1.22	0.14
	Confusion	0.73	0.11
Emotional*		7.29	0.05
	Emotional	1.25	0.27
	Irritability	1.29	0.07
	Sadness	0.86	0.48
	Nervousness	1.11	0.55
Sleep		0.81	0.72
	Drowsiness	0.98	0.89
	Difficulty falling asleep	0.85	0.21
PCSS total†		1.02	0.01

*Where a strong trend toward significance was noted.
†Where significance was reached ($P < 0.05$).

and *Emotional* category) within 10 days of injury, in a hospital-based, clinical rehabilitation setting, predict delayed recovery in the youth and adolescent population. Other factors such as age, sex, history of concussion, number of previous concussions, history of anxiety, depression, learning disability, attention problems, and sleep disturbances do not seem to be predictors of delayed recovery in the pediatric population.

Results support those of previous studies,[7,11] where delayed recovery in the pediatric population was associated with higher PCSS score at the time of injury, regardless of other factors such as age, sex, medical history, etc. Results as such[7,11] demonstrate that, in a clinical setting, self-reported symptoms may be used as a predictor of delayed recovery in the youth and adolescent population after suffering a concussion, whether they are assessed at the moment of the injury or more importantly a few days later.

Special attention in future researches should focus on presentation of symptoms from PCSS categories (physical, cognitive, emotional, and sleep). In this study, the *Emotional* category symptom percentage score seemed to represent a prediction factor for delayed recovery. These results support a study by Cunningham et al,[12] where, in individuals aged 14 years and older, seeking hospital care, somatic symptoms tended to decrease in time, whereas symptoms of cognitive and emotional nature tended to persist. Hence, future research should focus on presentation of persisting symptoms, especially those of emotional nature.

A limitation of this study was the number of participants involved in the statistical analysis. A greater number of children could have brought more power to the analyses and potentially solidify results when it comes to postconcussion symptoms.

REFERENCES
1. McCrory P, Meeuwisse W, Aubry M, et al. Consensus statement on concussion in sport: the 4th International Conference on concussion in sport, held in Zurich November 2012. *Clin J Sport Med*. 2013;23:89–117.
2. McCrea M, Guskiewicz K, Marshall SW, et al. Acute effects and recovery time following concussion in collegiate football players: the NCAA study. *JAMA*. 2003;290:2556–2563.
3. Barlow KM, Crawford S, Stevenson A, et al. Epidemiology of postconcussion syndrome in pediatric mild traumatic brain injury. *Pediatrics*. 2010;126:e374–e381.
4. World Health Organization, *International Classification of Diseases and Health Related Problems*. ICD-10. Diss. World Health Organization. 2004.
5. Collins MW, Iverson GL, Lovell MR, et al. On-field predictors of neuropsychological and symptom deficits following sports-related concussion. *Clin J Sport Med*. 2003;13:222–229.
6. Lau BC, Kontos AP, Collins MW, et al. Which on-field signs/symptoms predict protracted recovery from sport-related concussion among high school football players? *Am J Sports Med*. 2011;39:2311–2318.
7. Makdissi M, Darby D, Maruff P, et al. Natural history of concussion in sport: markers of severity and implications for management. *Am J Sports Med*. 2010;38:464–471.
8. Setnik L, Bazarian JJ. The characteristics of patients who do not seek medical treatment for traumatic brain injury. *Brain Inj*. 2007;21:1–9.
9. World Health Organization. *Neurological Disorders: Public Health Challenges*. World Health Organization. 2006.
10. McCrory P, Meeuwisse W, Johnston K, et al. Consensus statement on concussion in sport, 3rd International Conference on concussion in sport, held in Zurich. *Clin J Sport Med*. 2008;2009:185–200.
11. Meehan WP, Mannix RC, Stracciolini A, et al. Symptom severity predicts prolonged recovery after sport-related concussion, but age and amnesia do not. *J Pediatr*. 2013;163:721–725.
12. Cunningham J, Brison RJ, Pickett W. Concussive symptoms in emergency department patients diagnosed with minor head injury. *J Emerg Med*. 2011;40:262–266.