Development of a Decision Rule for Children at High Risk of Prolonged Post-Concussive Syndrome

Kara Seaton MD[1], Robert Doss PsyD[2,3], Joseph Petronio MD[2], Henry Ortega MD[1], and Anupam Kharbanda MD[1]
[1]Children's Hospitals and Clinics of Minnesota Division of Emergency Medicine, [2]Children's Neuroscience Center, [3]Minnesota Epilepsy Group

Children's Hospitals and Clinics of Minnesota
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Background

- One out of every 220 Pediatric Emergency Department visits is for concussion.
- While many children have an uneventful recovery, some will go on to have prolonged symptoms lasting weeks to months.
- To date, there is no consensus on how to predict which patients will have a typical recovery, and which will develop prolonged post-concussive syndrome (PCS) at the time of injury.

Objective

- **To identify clinical parameters associated with prolonged PCS in pediatric patients diagnosed with concussion.**
- **To develop a clinical decision rule to identify children at high risk for prolonged post-concussive symptoms.**

Methods

- **Study Design:** Retrospective cohort study, with data collected from September 2011 through February 2013.
- **Subjects:** Children 8-18 years who were diagnosed with concussion and sought care at a multidisciplinary concussion clinic.
- **Outcome:** Prolonged recovery, with symptoms lasting > 14 days.
- **Exclusion Criteria:** Age < 8 years, neurosurgical intervention, abnormal findings on radiologic studies, or unknown time to recovery.
- **Analysis:** We used the Chi-square test for categorical variables, and t-test for continuous variables. Variables that were significantly associated with prolonged PCS were then analyzed using recursive partitioning (RP) to develop a high risk clinical decision tool. In model creation, we aimed for a sensitivity > 90% and a specificity of > 20%.

Results

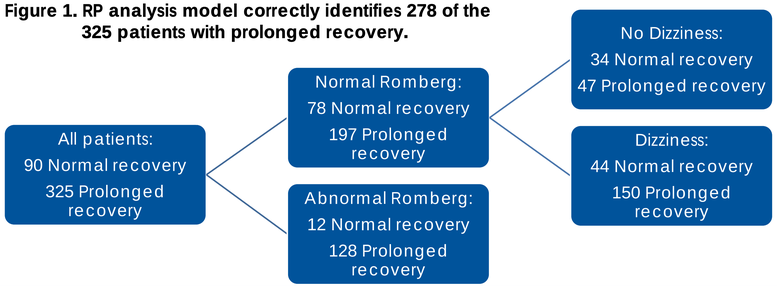
Table 1. Demographics.

	All patients	Normal recovery	Prolonged recovery	p Value
Age	13.2 (SD = 2.5)	12.8 (SD = 2.8)	13.3 (SD = 2.4)	0.08
Male gender	255 (61%)	67 (74%)	188 (58%)	0.004
Recovery time (days)	28 (IQR = 16-52)	10 (IQR = 4-12)	36 (IQR = 22-62)	<0.001
Mechanism				
•Sport	294 (71%)	55 (61%)	239 (74%)	
•Fall	54 (13%)	12 (13%)	42 (13%)	0.02
•Other	67 (16%)	23 (26%)	44 (14%)	

Table 2. Clinical predictors of prolonged recovery.

Clinical Predictor	Sensitivity, %	Specificity, %	PPV, %	p Value
Vomiting	9.9	78.9	62.7	0.014
Dizziness	79.6	42.2	83.2	< 0.001
Difficulty with balance	56.5	63.3	84.7	0.002
Romberg test	42.8	85.0	91.4	< 0.001
Tandem gait test	24.2	93.4	93.0	0.01

Figure 1. RP analysis model correctly identifies 278 of the 325 patients with prolonged recovery.



Key Results

- A total of 472 patients were enrolled over the 18 month study period, with 415 patients eligible for inclusion in the study.
- Gender was significantly associated with recovery, with females being more likely to have PCS (p = 0.004).
- The following parameters were not significantly associated with developing PCS: headache, loss of consciousness, wearing a helmet, problems with gait, or history of prior concussion, migraine, or depression.
- The RP model identified a) abnormal Romberg or b) normal Romberg with the presence of dizziness as key parameters associated with increased risk of PCS.
  - Sensitivity of 85.5% (95% CI 81.1-89.1)
  - Specificity of 37.8% (95% CI 28.0-48.7)

Conclusion

- Patients who present with concussion and have an abnormal Romberg or dizziness at the time of injury are at higher risk of PCS.
- This rule could easily be utilized in the ED to quickly assess patient risk.
- Early identification of patients at high risk for PCS could help to set reasonable expectations about recovery for families, including return to school and return to play.

Limitations

- Single center study.
- Our patient population was skewed towards a longer recovery, which may represent a selection bias of patients evaluated in the concussion clinic.
- Before clinical usage, it will be necessary to further assess the clinical decision tool. Ideally this would be done using a prospective, multicenter approach.