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Outpatient follow-up and return to school after emergency department evaluation among children with persistent post-concussion symptoms

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Abstract

Objective—To describe differences in outpatient follow-up and academic accommodations received by children with and without persistent post-concussion symptoms (PPCS) after emergency department (ED) evaluation. We hypothesised that children with PPCS would have more outpatient visits and receive academic accommodations more often than children without PPCS and that follow-up would be positively associated with receiving accommodations.

Methods—Children aged 8–18 years with acute (≤6 hours) concussion at time of presentation to a paediatric ED were enrolled in an observational study. Outcomes were assessed though telephone survey 30 days after injury.

Results—Of 234 enrolled participants, 179 (76%) completed follow-up. PPCS occurred in 21%. Only 45% of subjects had follow-up visits after ED discharge. Follow-up visit rates were similar for those with and without PPCS (58% vs. 41% respectively; p=0.07). Children with PPCS missed twice as many school days as those without (3 vs 1.5; p<0.001) but did not differ in receiving academic accommodations (36% vs 53%; p=0.082). Outpatient follow-up was associated with receiving academic accommodations (RR 2.2; 95% CI 1.4–3.5).

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Conclusions—Outpatient follow-up is not routine for concussed children. Despite missing more school days, children with PPCS do not receive academic accommodations more often. Outpatient follow-up may facilitate academic accommodations.

Keywords

brain concussion; brain injury; acute; brain injury; traumatic; post-concussion symptoms; post-concussion syndrome; emergency medicine

Introduction

After paediatric concussion, studies using performance-based tests provide little evidence that neuropsychological difficulties persist beyond the initial days to weeks.[1–4] This corresponds with conclusions of meta-analytic studies of paediatric and adult samples.[5, 6] In contrast, when examining outcomes using subjectively reported symptoms, a minority of paediatric patients endorse more persistent problems. For example, some studies suggest that 14–29% of children remain symptomatic for at least three months and others have found that symptoms can last up to a year.[7–9]

The aetiology of persistent post-concussive problems has been the subject of significant controversy. In general, injury factors have been found to play a larger role initially while non-injury factors (e.g. demographic variables, coping style) have been found to play a more significant role with increasing time post-injury. Regardless of aetiology, post-injury symptomatology can have functional consequences,[10, 11] requiring attention from primary care providers (PCPs).

The literature aimed at helping PCPs manage recovery in concussed children has focused primarily on facilitating athletes' safe return-to-play. Historically, much less attention has been given to transitioning children back to school – the "return to learn" process. However, in the last few years, several authors have published recommendations to guide re-entry to the classroom.[12–14] A recent Clinical Report from the American Academy of Pediatrics stressed the importance of medical teams, including PCPs, partnering with schools to return children to the classroom after concussion.[15] Additionally, adolescents and parents believe that improved healthcare-school partnerships would aid the return to academic pursuits.[16]

To assist with returning to school, PCPs must have contact with patients. However, initial concussion care frequently occurs in the emergency department (ED).[17] Therefore, outpatient follow-up after a concussion comprises an important component of ongoing assessment and management of persistent symptoms enabling a successful transition back to school.

As a preliminary step to better understand the interaction among persistent concussion symptoms, primary care follow-up and school support, we conducted a secondary analysis of data from a short-term observational cohort study of children initially evaluated in an ED for acute concussion. We hypothesised that compared to children with early symptom resolution, children experiencing persistent post-concussive symptoms (PPCS) one month following injury would: 1) have more follow-up visits with PCPs and/or specialists; 2) miss

more school days; and 3) be more likely to receive academic accommodations. We also examined the relationship between follow-up care and academic accommodations.

Study design

We performed a secondary analysis of a prospective longitudinal cohort study of children who sustained concussion ≤6 hours prior to presenting to a level 1 paediatric trauma center ED. Participants 8–18 years old were enrolled from October 1, 2010 to March 31, 2013. Participants were contacted by telephone 30 days following injury to complete follow-up questionnaires. Participants not contacted after three attempts were considered lost to follow-up. Data were managed using Research Electronic Data Capture (REDCap) hosted by the Colorado Clinical and Translational Science Institute.[18] The study was approved by the Colorado Multiple Institutional Review Board.

Participants

Following previously reported clinical definitions of concussion,[11, 19, 20] participants were considered to have a concussion if they had: a Glasgow Coma Scale (GCS) score of 13 or 14; or a GCS score of 15 with ≥2 of the following symptoms occurring after a direct blow to or rapid acceleration/deceleration of the head: loss of consciousness; post-traumatic amnesia; disorientation to person, place or time; subjective feelings of slowed thinking; perseveration; vomiting/nausea; headache; diplopia/blurry vision; dizziness or somnolence. GCS and symptoms were assessed by paediatric emergency medicine providers. Children were excluded if they presented with: open head injuries; intoxication with alcohol or controlled substances; injuries from child abuse; multi-system injuries; underlying central nervous system abnormalities; or more than 6 hours after injury. Participants not proficient in English were also excluded as not all instruments used for the study are validated for non-English speakers.

Measurements

Self-reported concussion symptoms were quantified using a graded concussion symptom inventory including 11 of 12 items (fatigue and drowsiness were combined into one item) from the Concussion Symptom Inventory (CSI)[21] plus three additional items regarding irritability, sadness and poor sleep which are not captured in the CSI but are known sequelae of concussion.[22] Subjects verbally rated the degree of symptoms they were experiencing. We modified the instrument for our paediatric population from a 0–6 point scale to a 0–2 point scale to ensure understanding (range 0–28). For example, children answering the question, ‘Do you have a headache?’ had the options: 0 (none at all), 1 (a little bit), 2 (a lot). Parents retrospectively rated children’s symptoms in the week prior to injury at time of enrollment using the same instrument to provide a pre-injury baseline.

During the 30-day follow-up call we again documented symptoms using the CSI. The *International Classification of Diseases, 10th Edition* (ICD-10) requires the presence of at least 3 of 8 possible symptoms to meet criteria for post-concussive syndrome. However, this definition does not account for presence of pre-injury symptoms.[23] To obtain a more precise estimate of PPCS, we defined PPCS as ≥3 symptoms one month after injury that were absent or less severe prior to the concussion.

During the follow-up call, we collected data regarding primary care and specialist visits, visits to other healthcare professionals, school absenteeism and academic accommodations using a scripted questionnaire. Any visit with a physician or advanced practice provider in a general paediatric or family medicine office was considered primary care. Specialist visits included those in dedicated “concussion clinics” or to sports medicine, neurology, and rehabilitation medicine offices.

School absenteeism was defined as any days missed expressly because of the concussion. We did not ascertain whether the days missed were due to ongoing symptoms or prescribed rest. We inquired whether children received academic accommodations at any time since the ED enrollment visit that were enacted because of the concussion. Accommodations included any informal change in workload, class time or study environment as well as formal interventions (e.g. Section 504 plans).[24]

Statistical analysis

Pre-injury symptom scores were subtracted from both the initial and 30-day follow-up scores to account for presence of non-specific symptoms due to other conditions. Symptoms present prior to injury but absent post-injury were scored as 0 (i.e., negative scores were not assigned). Descriptive statistics for demographic and acute injury data were calculated as proportions or means with standard deviation. Outcomes were compared between those with and without PPCS using chi-square tests or Fisher’s exact tests when cell frequencies were <6. Wilcoxon Rank Sum Test was used to compare non-normally distributed data (e.g. number of healthcare visits). Results were considered significant if $p < 0.05$. We calculated a risk ratio and 95% confidence interval (CI) for receiving special academic accommodations if participants had any follow-up visit, stratified by whether participants had PPCS. Results were considered significant if the CI did not contain 1.

Results

During the study period, 273 patients presenting to the ED with concussion were eligible: 32 patients declined enrollment and seven met exclusion criteria. Of the 234 enrolled, 179 (76%) participants completed the CSI administered in the ED and the 30-day follow-up telephone survey. Patients not included in the final cohort because they did not complete follow-up surveys did not differ from participants in age, sex, initial GCS, injury mechanism, or prior concussion history. Based on follow-up survey data, 38 children (21%) met the study definition of PPCS. There were no significant differences in demographic or injury characteristics for those with and without PPCS (table 1). Of note, the five participants who had abnormal head computed tomography results all belonged to the No PPCS group and none required neurosurgical intervention or admission. Three participants experienced a subsequent concussion in the follow-up period (No PPCS = 2, PPCS = 1).

Follow-up visits

The number of PCP and subspecialty follow-up visits was similar for participants with and without PPCS during the one-month follow-up period (table 2). Less than half of all participants had PCP follow-up in the month following concussion. There was a higher

proportion of participants with PPCS having PCP follow-up (41% vs. 58%) although this was not significant (p=0.07). The number of PCP visits was similar between groups. There was no difference in the proportion evaluated by specialists or number of specialist visits. Visits to other healthcare providers are also shown.

School absenteeism and academic accommodations

Twenty one subjects (17 without, 4 with PPCS) who enrolled or had 30-day follow-up during school holidays were not included in school absenteeism analyses. Ninety-six percent of children without PPCS and 100% with PPCS had returned to school full time (p=0.99). However, subjects with PPCS missed twice as many days of school as those without PPCS (3 vs 1.5, $p < 0.001$; table 3). Overall, the days missed ranged from 1–16. Although children with PPCS tended to receive academic accommodations more often (53% vs 36%), this did not reach significance (p=0.08). Academic accommodations were limited to informal arrangements for 96% (55/57) of subjects who received them. Two subjects had Section 504 plans enacted.

Children without PPCS, were more likely to receive academic accommodations if they had a follow-up visit compared to those without follow-up (RR = 2.3, 95% CI 1.3–3.9). When all subjects were pooled, this association held (RR = 2.2, 95% CI 1.4–3.5). There were too few children with PPCS to calculate a reliable relative risk estimate in this group.

Discussion

This study, one of the first to describe the relationship between outpatient follow-up and return to school among children discharged from the emergency department after acute concussion evaluation, showed that fewer than half of all patients attended follow-up visits or received academic accommodations in the month following injury. The low proportion seeking follow-up in our study mimics that seen in a similar population.[25] This finding is concerning as one of the main goals for a successful return to the classroom is avoiding symptom exacerbation through academic accommodations which can be facilitated by healthcare providers.[26] Recent research suggests that while complete cognitive rest may not be beneficial, unrestricted cognitive activity is associated with a longer duration of post-concussive symptoms.[27] While there is little direct evidence in previously published studies demonstrating that PCP-involvement improves the likelihood of receiving academic support, our data demonstrate a positive association between PCP follow-up and receipt of academic accommodations.

As described above, persistent symptoms are a major focus in alerting PCPs to the potential need for additional resources among children recovering from concussions. Therefore, we dichotomized our cohort based on presence or absence of PPCS. Children without PPCS at 30 days demonstrated a distribution of CSI scores very similar to their pre-injury baseline whereas children with PPCS had significantly more symptoms. Additionally, the lack overlap in the IQR of scores for the two groups suggests a clinically relevant difference. In contrast, the distribution of baseline scores was also significantly different but there is considerable overlap in the IQR for these scores which is unlikely to be clinically meaningful.

Follow-up visits

Contrary to our hypothesis, the proportion of children initially evaluated in the ED for concussion, who attended a follow-up visit with a PCP did not differ depending on presence or absence of PPCS. While we did identify a tendency toward increased PCP follow-up among children with PPCS, only 58% reported a follow-up visit. Though this tendency may have become significant with a larger sample size, it remains concerning that less than half of all children with concussion in our sample visited a PCP in the month after injury as there is no reliable means of predicting development of persistent symptoms.

We found no difference in the number of PCP visits one month after concussion between those with and without PPCS. The recent AAP Clinical Report[15] recommends that children with symptoms lasting more than three weeks may require additional resources such as specialist involvement and formal academic support (e.g. Section 504 plan). Whether considering recommendations for specialist referral[28] or determining the need for academic accommodations,[29] ongoing assessment of concussion symptoms represents a cornerstone of concussion management. Our data do not allow us to conclude that children are not receiving appropriate recovery supervision. Yet, the lack of a difference in PCP visits suggests that children with PPCS are no more closely monitored in the month following concussion than those children whose symptoms resolve. Since PPCS are typically most severe in the first month after injury,[30, 31] this is the period requiring the closest supervision.

Similar to our findings regarding PCP follow-up, we found that the proportion of children visiting a specialist and number of specialist visits did not differ relative to PPCS. Although 89% of paediatricians surveyed believed they were the most appropriate provider for concussion follow-up care, that proportion fell to 5% when patients displayed persistent symptoms.[28] Additionally, 90% of PCPs report referring at least some patients with concussion to specialists, particularly if uncomfortable with management or when management resources are insufficient.[32] Knowing this, we expected specialist visits to be more frequent among children with PPCS but our data did not support this. Of course, it is possible that we did not find a difference in these variables due to the brief duration of follow-up in our study.

Although there is no direct evidence that PCP or specialist follow-up improves short-term outcomes for children with concussion, some evidence suggests that follow-up adds value to the care of this population. Slomine and colleagues studied children hospitalized at least one night for traumatic brain injuries including 100 children with an Abbreviated Injury Scale score of 2 (concussion with loss of consciousness < 1 hour). The study found that three months after injury, unmet or unrecognised healthcare needs existed in 32% and 45% of children, respectively. Cognitive services represented the most common category of unmet or unrecognised need.[33] When the entire cohort was re-examined at 12 months, the proportion of children who had a physician visit increased while the proportion with unmet/unrecognised needs declined. The authors encouraged PCP follow-up for all patients in order to discover and meet needs in a timely manner. It is worth noting that PCPs likely lack sufficient training in neurocognitive assessment to best identify the academic needs of concussed children.[28, 32]

School absenteeism and academic accommodations

In our total cohort, 72% of participants reported missing at least one day of school. The proportions did not differ with respect to the presence of PPCS. As expected, we did find that children with PPCS miss twice as many school days as children without PPCS, although children with PPCS were back to school in a median of 3 days. Most children missed less than 5 days of school, consistent with findings in a similar population.[34] Our study cannot address the direct impact of PPCS on cognitive performance, but it demonstrates that PPCS interfere at a basic level by disrupting school attendance. While it could be argued that patients with high symptom burdens should not be in the classroom, our data provide an approximation of the duration of school absence that could be expected following a concussion resulting in persistent symptoms. This may assist PCPs when considering the timing of referring persistently symptomatic patients for specialty consultation and alert them to the need for accommodations upon school return.

We were encouraged to find that 40% of all participants received academic accommodations upon school return. Although our data cannot elucidate the appropriateness of the accommodations, they indicate educators are assisting many children returning to school after a concussion. Nonetheless, only 53% of participants with PPCS reported receiving academic accommodations. This is an improvement compared to 27% reported previously.[35] Yet, it affirms existing recommendations to communicate with school personnel about ongoing symptoms so that support can be provided to the student.

Presumably, this communication can be improved with PCP involvement. We found a positive association between follow-up visits and the receipt of academic accommodations in our cohort. Our study design allows two possible explanations of this association. First, children seen in follow-up are receiving assistance from healthcare providers in communicating with schools about the need for support. Alternatively, school personnel are recognizing that children in need of academic support may also have ongoing medical concerns that require the attention of a healthcare provider. In either case, patients likely benefit from communication between school and healthcare providers.

Limitations

We sampled only children evaluated in the ED and did not collect data on income, insurance status or whether subjects had an established PCP. Our urban ED patient population is predominantly publicly insured which may be associated with less access to primary care.[36, 37] Therefore, rates of PCP and specialist follow-up from our study may not be generalizable. Furthermore, parents may have felt the ED visit adequately addressed their concerns and concluded further medical care was unnecessary.

We collected number of days missed but not underlying reasons. Thus, we cannot verify all school absenteeism was the result of being symptomatic. Alternate reasons for missed school include PCP or school personnel recommendations for cognitive rest.[38] Additionally, because we limited our follow-up to one month, we may have underestimated the proportion of participants with PPCS who ultimately received academic accommodations. This underestimation is likely small as the 75th percentile for days missed

was 5 and follow-up occurred at 30 days allowing time for ongoing symptoms to come to the attention of parents and teachers.

The prevalence of PPCS at one month in our study (21%) was lower than reports of similar populations at 30 days (32–59%)[7, 20] which may have affected our ability to show differences between children with and without PPCS. Finally, this study represents secondary data analysis and is, therefore, preliminary requiring further directed investigation to confirm these observations. Despite these limitations, ours is one of the first studies to describe rates of outpatient follow-up, school absenteeism and receipt of academic accommodations among a paediatric concussion cohort initially evaluated in the ED.

Conclusions

Children who develop PPCS are no more likely to receive outpatient follow-up in the month following a concussion than those without PPCS. Despite missing twice as many days of school, children with PPCS are no more likely to receive academic accommodations than those without PPCS. Although our data provide preliminary support for the hypothesis that outpatient follow-up improves the likelihood of receiving academic accommodations, further research should focus on demonstrating that follow-up not only improves the chances that children requiring support receive it but also that the support addresses each child's specific needs.

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Abbreviations

CSI	Concussion Symptom Inventory
ED	emergency department
GCS	Glasgow Coma Scale
PCP	primary care provider
PPCS	persistent post-concussion symptoms

References

1. Bijur PE, Haslum M, Golding J. Cognitive and behavioral sequelae of mild head injury in children. Pediatrics. 1990; 86(3):337–44. [PubMed: 2388783]
2. Fay GC, Jaffe KM, Polissar NL, Liao S, Martin KM, Shurtleff HA, Rivara JM, Winn HR. Mild pediatric traumatic brain injury: a cohort study. Arch Phys Med Rehabil. 1993; 74(9):895–901. [PubMed: 8379832]
3. Maillard-Wermelinger A, Yeates KO, Gerry Taylor H, Rusin J, Bangert B, Dietrich A, Nuss K, Wright M. Mild traumatic brain injury and executive functions in school-aged children. Dev Neurorehabil. 2009; 12(5):330–41. [PubMed: 20477562]

4. Babikian T, Satz P, Zaucha K, Light R, Lewis RS, Asarnow RF. The UCLA longitudinal study of neurocognitive outcomes following mild pediatric traumatic brain injury. J Int Neuropsychol Soc. 2011; 17(5):886–95. [PubMed: 21813031]
5. Belanger HG, Vanderploeg RD. The neuropsychological impact of sports-related concussion: a meta-analysis. J Int Neuropsychol Soc. 2005; 11(4):345–57. [PubMed: 16209414]
6. Babikian T, Asarnow R. Neurocognitive outcomes and recovery after pediatric TBI: meta-analytic review of the literature. Neuropsychology. 2009; 23(3):283–96. [PubMed: 19413443]
7. Barlow KM, Crawford S, Stevenson A, Sandhu SS, Belanger F, Dewey D. Epidemiology of postconcussion syndrome in pediatric mild traumatic brain injury. Pediatrics. 2010; 126(2):e374–81. [PubMed: 20660554]
8. Babcock L, Byczkowski T, Wade SL, Ho M, Mookerjee S, Bazarian JJ. Predicting postconcussion syndrome after mild traumatic brain injury in children and adolescents who present to the emergency department. JAMA Pediatr. 2013; 167(2):156–61. [PubMed: 23247384]
9. Yeates KO, Taylor HG, Rusin J, Bangert B, Dietrich A, Nuss K, Wright M, Nagin DS, Jones BL. Longitudinal trajectories of postconcussive symptoms in children with mild traumatic brain injuries and their relationship to acute clinical status. Pediatrics. 2009; 123(3):735–43. [PubMed: 19254996]
10. Ganesalingam K, Yeates KO, Ginn MS, Taylor HG, Dietrich A, Nuss K, Wright M. Family burden and parental distress following mild traumatic brain injury in children and its relationship to post-concussive symptoms. J Pediatr Psychol. 2008; 33(6):621–9. [PubMed: 18227110]
11. Moran LM, Taylor HG, Rusin J, Bangert B, Dietrich A, Nuss KE, Wright M, Yeates KO. Do postconcussive symptoms discriminate injury severity in pediatric mild traumatic brain injury? J Head Trauma Rehabil. 2011; 26(5):348–54. [PubMed: 21900857]
12. Master CL, Gioia GA, Leddy JJ, Grady MF. Importance of 'return-to-learn' in pediatric and adolescent concussion. Pediatr Ann. 2012; 41(9):1–6.
13. Sady MD, Vaughan CG, Gioia GA. School and the concussed youth: recommendations for concussion education and management. Phys Med Rehabil Clin N Am. 2011; 22(4):701–19. ix. [PubMed: 22050944]
14. McGrath N. Supporting the student-athlete's return to the classroom after a sport-related concussion. J Athl Train. 2010; 45(5):492–8. [PubMed: 20831397]
15. Halstead ME, McAvoy K, Devore CD, Carl R, Lee M, Logan K. Returning to learning following a concussion. Pediatrics. 2013; 132(5):948–57. [PubMed: 24163302]
16. Gagnon I, Swaine B, Champagne F, Lefebvre H. Perspectives of adolescents and their parents regarding service needs following a mild traumatic brain injury. Brain Inj. 2008; 22(2):161–73. [PubMed: 18240045]
17. Meehan WP 3rd, Mannix R. Pediatric concussions in United States emergency departments in the years 2002 to 2006. J Pediatr. 2010; 157(6):889–93. [PubMed: 20708747]
18. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)--a metadata-driven methodology and workflow process for providing translational research informatics support. J Biomed Inform. 2009; 42(2):377–81. [PubMed: 18929686]
19. Meehan WP 3rd, Bachur RG. Sport-related concussion. Pediatrics. 2009; 123(1):114–23. [PubMed: 19117869]
20. Eisenberg MA, Andrea J, Meehan W, Mannix R. Time interval between concussions and symptom duration. Pediatrics. 2013; 132(1):8–17. [PubMed: 23753087]
21. Randolph C, Millis S, Barr WB, McCrea M, Guskiewicz KM, Hammeke TA, Kelly JP. Concussion symptom inventory: an empirically derived scale for monitoring resolution of symptoms following sport-related concussion. Arch Clin Neuropsychol. 2009; 24(3):219–29. [PubMed: 19549721]
22. Blume H, Hawash K. Subacute concussion-related symptoms and postconcussion syndrome in pediatrics. Curr Opin Pediatr. 2012; 24(6):724–30. [PubMed: 23128838]
23. Organization, W.H. The ICD-10 Classification of Mental and Behavioral Disorders: Clinical Description and Diagnostic Guidelines. Geneva: World Health Organization; 1992.
24. American Academy of Pediatrics Council on Children. With D, Cartwright JD. Provision of educationally related services for children and adolescents with chronic diseases and disabling conditions. Pediatrics. 2007; 119(6):1218–23. [PubMed: 17545394]

25. Zuckerbraun NS, Atabaki S, Collins MW, Thomas D, Gioia GA. Use of modified acute concussion evaluation tools in the emergency department. Pediatrics. 2014; 133(4):635–42. [PubMed: 24616361]
26. Popoli DM, Burns TG, Meehan WP 3rd, Reisner A. CHOA Concussion Consensus: Establishing a Uniform Policy for Academic Accommodations. Clin Pediatr (Phila). 2013
27. Brown NJ, Mannix RC, O'Brien MJ, Gostine D, Collins MW, Meehan WP 3rd. Effect of Cognitive Activity Level on Duration of Post-Concussion Symptoms. Pediatrics. 2014
28. Kaye AJ, Gallagher R, Callahan JM, Nance ML. Mild traumatic brain injury in the pediatric population: the role of the pediatrician in routine follow-up. J Trauma. 2010; 68(6):1396–400. [PubMed: 20539184]
29. Halstead ME, Walter KD. American Academy of Pediatrics. Clinical report--sport-related concussion in children and adolescents. Pediatrics. 2010; 126(3):597–615. [PubMed: 20805152]
30. Hajek CA, Yeates KO, Taylor HG, Bangert B, Dietrich A, Nuss KE, Rusin J, Wright M. Agreement between parents and children on ratings of post-concussive symptoms following mild traumatic brain injury. Child Neuropsychol. 2011; 17(1):17–33. [PubMed: 20680882]
31. Taylor HG, Dietrich A, Nuss K, Wright M, Rusin J, Bangert B, Minich N, Yeates KO. Post-concussive symptoms in children with mild traumatic brain injury. Neuropsychology. 2010; 24(2): 148–59. [PubMed: 20230109]
32. Zonfrillo MR, Master CL, Grady MF, Winston FK, Callahan JM, Arbogast KB. Pediatric providers' self-reported knowledge, practices, and attitudes about concussion. Pediatrics. 2012; 130(6):1120–5. [PubMed: 23147981]
33. Slomine BS, McCarthy ML, Ding R, MacKenzie EJ, Jaffe KM, Aitken ME, Durbin DR, Christensen JR, Dorsch AM, Paidas CN. Health care utilization and needs after pediatric traumatic brain injury. Pediatrics. 2006; 117(4):e663–74. [PubMed: 16533894]
34. Zemek R, Clarkin C, Farion KJ, Vassilyadi M, Anderson P, Irish B, Goulet K, Barrowman N, Osmond MH. Parental anxiety at initial acute presentation is not associated with prolonged symptoms following pediatric concussion. Acad Emerg Med. 2013; 20(10):1041–9. [PubMed: 24127708]
35. Hawley CA, Ward AB, Magnay AR, Mychalkiw W. Return to school after brain injury. Arch Dis Child. 2004; 89(2):136–42. [PubMed: 14736628]
36. Berman S, Armon C, Todd J. Impact of a decline in Colorado Medicaid managed care enrollment on access and quality of preventive primary care services. Pediatrics. 2005; 116(6):1474–9. [PubMed: 16322173]
37. Haboush-Deloye A, Hensley S, Teramoto M, Phebus T, Tanata-Ashby D. The Impacts of Health Insurance Coverage on Access to Healthcare in Children Entering Kindergarten. Matern Child Health J. 2013
38. Prevention, C.f.D.C.a. Heads Up to Schools: Know Your Concussion ABCs. [Web Page] [cited 2013 August 30]; Available from: http://www.cdc.gov/concussion/pdf/TBI_factsheet_TEACHERS-508-a.pdf

Table 1

Demographic and Injury Characteristics for No PPCS and PPCS groups

	No PPCS (n=141)	PPCS (n=38)
Demographics		
Mean Age	12.6 SD 2.5	13.4 SD 2.2
Male	70%	66%
History of Prior Concussion	25%	25%
Injury Characteristics		
Mechanism		
Sport	48%	53%
Fall	43%	34%
Assault	3%	5%
Motor vehicle collision	1%	3%
Other	5%	5%
Median Initial Glasgow Coma Scale Score[a]	15	15
History of Loss of Consciousness	26%	29%
History of Post-traumatic amnesia	26%	34%
Received Head CT in Emergency Department	21%	26%
Abnormal Head CT Results	4%	0%
Preinjury Graded Symptom Score, median (IQR)[b]	1 (0–2)	2 (1–4)
Initial ED Graded Symptom Score, median (IQR)[c]	9 (6–13)	11 (7–15)
30-Day Graded Symptom Score, median (IQR)[d]	0 (0–1)	4 (3–7)

[a] Interquartile range for both groups was 15-15.

[b] Wilcoxon Rank Sum p = 0.002

[c] Wilcoxon Rank Sum p = 0.14

[d] Wilcoxon Rank Sum p <0.001

Table 2

Follow-up Visits after Emergency Department Evaluation for Acute Concussion

	Full Cohort	No PPCS (n=141)	PPCS (n=38)	p-values
Proportion with follow-up visit				
At least 1 primary care visit (%)	45	41	58	0.07
At least 1 subspecialty visit (%)	11	9	16	0.24
Visits to other healthcare providers				
Neuropsychologist (%)	3	4	3	1
Psychologist	3	4	3	1
Physical Therapist	3	4	3	1
Other*	3	1	11	0.02
Repeat visit to ED or urgent care (%)	3	1	5	0.05
Number of visits for those seen for follow-up				
Primary care visits, median (IQR)†	1 (1–1.5)	1 (1–1)	1 (1–2)	0.35
Subspecialty visits, median (IQR)†	1 (1–2.5)	1 (1–1)	1 (1–3)	0.74

*Other includes: 2 visits with athletic trainers, 2 with dentists and 1 each with a chiropractor and a homeopathic practitioner.

†Comparisons of number of visits were made only between children reporting that they had a primary care or subspecialty visit.

Table 3

School Absenteeism and Academic Accommodations following Concussion

	Full Cohort	No PPCS (n=124)*	PPCS (n=34)*	p-values
Missed at least 1 day of school (%)	72	69	82	0.27
Receiving special accommodations (%)	40	36	53	0.082
Days of school missed (median, IQR)†	2 (1–3)	1.5 (1–2)	3 (2–5)	**<0.001**

*21 participants were enrolled or had follow-up during school holidays and were not included in analysis.

†Days of school missed were recorded only for those who reported missing at least one day of school.