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"My Child Doesn't Have a Brain Injury, He Only Has a Concussion"

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KEY WORDS

adolescent, brain concussion, brain injuries, child, pediatric hospitals

ABBREVIATIONS

LOC—loss of consciousness
GCS—Glasgow Coma Scale
TBI—traumatic brain injury
MTBI—mild traumatic brain injury
MCH—McMaster Children's Hospital
CT—computed tomography
OR—odds ratio
CI—confidence interval

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WHAT'S KNOWN ON THIS SUBJECT: The term "concussion" is frequently used in clinical records to describe traumatic head injury, yet there has been no agreement on the definition of this term and its application, particularly within the pediatric population.

WHAT THIS STUDY ADDS: We examined the clinical correlates of the concussion diagnosis and identified factors that lead to the term's use. The findings suggest that the term "MTBI" might be more appropriate than "concussion" for both clinical and research purposes.

abstract

OBJECTIVE: The term "concussion" is frequently used in clinical records to describe a traumatic head injury; however, there are no standard definitions of this term, particularly in how it is used with children. The goals of this study were to examine the clinical correlates of the concussion diagnosis and to identify the factors that lead to the use of this term in a regional pediatric center.

METHODS: Medical data were prospectively collected from 434 children with traumatic brain injury who were admitted to a Canadian children's hospital. A proportional hazards regression was used to examine the association of the concussion diagnosis and the times until discharge and school return. A classification-tree analysis modeled the clinical correlates of patients who received a concussion diagnosis.

RESULTS: The concussion label was significantly more likely to be applied to children with mild Glasgow Coma Scale scores of 13 to 15 ($P = .03$). The concussion label was strongly predictive of earlier hospital discharge (odds ratio [OR]: 1.5; 95% confidence interval [CI]: 1.2–1.9; $P = .003$) and earlier return to school (OR: 2.4 [95% CI: 1.6–3.7]; $P < .001$). A diagnosis of a concussion was significantly more likely when the computed-tomography results were normal and the child had lost consciousness.

CONCLUSIONS: Children with mild traumatic brain injuries have an increased frequency of receiving the concussion label, although the label may also be applied to children with more-severe injuries. The concussion diagnosis is associated with important clinical outcomes. Its typical use in hospital settings likely refers to an impact-related mild brain injury, in the absence of indicators other than a loss of consciousness. Clinicians may use the concussion label because it is less alarming to parents than the term mild brain injury, with the intent of implying that the injury is transient with no significant long-term health consequences. *Pediatrics* 2010;125:327–334

The terminology surrounding trauma to the head confuses patients, doctors, and lay commentators alike.
Tim Anderson, Marcus Heitger, and A. D. Macleod[1](p342)

The term "concussion" is frequently used in clinical records to describe traumatic head injury, yet there has been no agreement on the definition of the term and its application, particularly as it applies to the pediatric population.[2–5] Although the concussion label is often used to indicate a mild injury, the *International Statistical Classification of Diseases and Related Health Problems, 10th Revision*[6] codes include 6 different categories of concussions that range from mild (S06.03), with a prolonged loss of consciousness (LOC) and a return to the preexisting level of consciousness, to severe (S06.04), with no return to consciousness and the inclusion of death as the outcome. There are currently at least 8 different scales for concussion, with no universal agreement on the definition or grades of concussion.[7,8] Grading systems represent the expertise of clinicians and researchers, but there is a lack of scientific evidence to support any of the concussion-grading systems. The Committee of Head Injury Nomenclature of the Congress of Neurologic Surgeons defined concussion as a clinical syndrome that is characterized by the immediate and transient impairment of neural functions caused by mechanical forces.[8] Part of the dilemma that contributes to the confusion is the use of the Glasgow Coma Scale (GCS). There is large variability in the use of GCS throughout the care process. In our experience and as reported by others, the GCS is not reliably recorded at the accident scene and is inconsistently recorded in the hospital record.[9] This use limits its value in categorizing mild injury, although it is consistently used as an element of the concussion diagnosis.[10] In comparison with adult patients, the classification of concussion for the pediatric population is further complicated by the difficulties of assessing subjective factors among children and by the uncertain consequences of head injury for the developing brain.[11–13] The common thread of each definition of concussion is related to the cause of injury being an impact or a jolt to the head,[3,4,14,15] whereas the symptoms and presentation of concussion differ on the basis of the definition source or grading system.

The Canadian Paediatric Society has attempted to define concussion in children by using the results of the First International Symposium on Concussion in Sport in 2001[16] and by using other sources such as the guidelines for the assessment and management of sport-related concussion from the Canadian Academy of Sport Medicine Concussion Committee[17] and the National Athletic Trainers' Association position statement on management of sport-related concussion.[18] The Canadian Paediatric Society has also emphasized concussion as an impact-related mild traumatic brain injury (MTBI):

> Concussion is defined as a complex pathophysiological process that affects the brain, induced by traumatic biomechanical forces resulting in the rapid onset of short-lived impairment of neurologic function that resolves spontaneously. Concussion may be sustained by a direct blow to the head, face, or neck or by a blow to somewhere else on the body that transmits an impulsive force to the head. Most concussions do not cause a LOC or cause only a transient (ie, lasting seconds) LOC.[10] Canadian Paediatric Society (p420)

For this study we adopted an empirical approach to understanding how clinicians in hospitals use the term "concussion," irrespective of the existing formal definitions. We expected that the concussion label is important because we assume that clinicians are using the term to communicate something important to parents and children. Parents, in particular, may understand concussion to mean that the condition is transient, with no significant health consequences. Both parents and clinicians may use the term to imply the exclusion of brain injury; during recruitment to this study, both parents and medical staff were frequently heard expressing the opinion that "he doesn't have a head injury, he has a concussion." Specifically, we hypothesized that the presence of the concussion label would be associated with an earlier discharge from the hospital and an earlier subsequent return to school. We also hypothesized that it is possible to identify patterns of clinical indicators in the hospital record that are predictive of a diagnosis of concussion, although the association with the severity of injury as measured by the GCS is unknown.

METHODS

Sample and Data Source

Medical variables were prospectively collected for all 434 children who were admitted to McMaster Children's Hospital (MCH) between November 2001 and December 2003 with a diagnosis of acquired brain injury. MCH is a tertiary care center and a children's trauma center that serves the region of central southwest Ontario with a population of ~2 000 000. Figure 1 summarizes the inclusions for the analyzed samples. Children were included in the analyses if they had a traumatic brain injury (TBI) and had GCS scores available. In addition, because initial computed-tomography (CT) scans were taken for 89% of the children, and because normal CT results were expected to predict a concussion diagnosis, the analyses were restricted to children for whom initial CT results were available, yielding a sample of 268 participants. The date of school return was available for 109 of these children (aged 5–18 years) who were enrolled in an ongoing cohort study, and these children were eligible for anal-

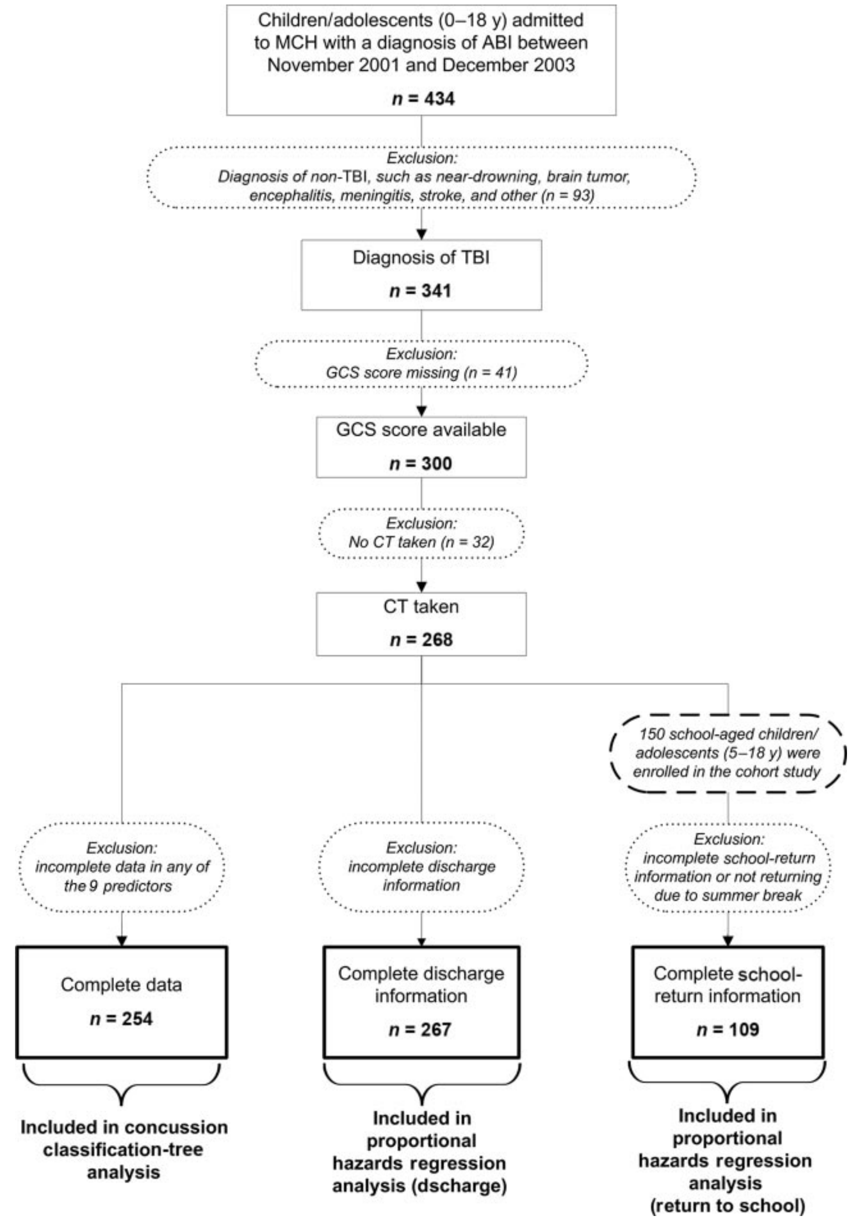

FIGURE 1
The study sample size at each stage of the analyses. ABI indicates acquired brain injury.

yses of the time until they returned to school. This study was conducted with approval of the McMaster University Health Sciences' Ethics Review Board.

Measures

Medical variables incorporating a wide range of clinical data were abstracted from the medical chart by trained assessors using a standardized form at the time of hospital admission until discharge. The GCS,[19–21] the most widely known and used scale in the assessment of level of consciousness,[22–24] was used to categorize children as having mild, moderate, or severe injury. GCS scores of 13 to 15 represent mild injury, scores of 9 to 12 represent moderate injury, and scores of 8 or fewer represent severe injury.[25] For children younger than 2 years of age, the pediatric version of the GCS[26–28] was used.

Concussion grading was not consistently used. Because there is no accepted concussion-grading system for children, a concussion was scored as being present if attending physicians made any notation of a concussion on the medical chart and was scored as absent otherwise. The reliability of the concussion diagnosis was not addressed in this study, because we were interested in predicting the use of the concussion label by physicians rather than the accuracy of the diagnosis.

The date of school return was assessed in telephone interviews with parents who participated in the cohort study. School-return time was calculated as the time from discharge to school return.

Statistical Analyses

We used proportional hazards regression to identify significant predictors of discharge time and school return from the medical variables. Each predictor was evaluated in a separate univariate model. Two additional analyses were conducted for those predictors that were significant, in which the predictor was adjusted for GCS severity (mild versus not mild) and the presence of other injuries that were not related to TBI.

Medical variables were selected as possible predictors of the concussion label if they were significant in the unadjusted analyses of discharge times or if they were strongly associated with the concussion label on a priori theoretical grounds, such as the clinical symptoms included in the concussion definitions (ie, vomiting or disorientation). The chosen predictors were used in a classification-tree analysis to model the clinical correlates of patients who received a concussion diagnosis. This method is an exploratory technique that can be used to devise prediction rules from multivariate data.[29] It uses a recursive partitioning algorithm to produce a set of prediction rules that relate the medical variables to the categorical outcome (ie, concussion) in the form of a binary decision tree. This technique has been used successfully by Brown et al,[30] Andrews et al,[31] and Choi et al[32] with large TBI databases to predict outcomes by using many acute variables.

In recursive partitioning, an initial split is obtained by evaluating which predictors and cut points produce the clearest division of the sample into concussion versus nonconcussion cases. The tree ends with terminal nodes or "leaves" that yield the probability of concussion for each combination of predictors.

The complete tree is subject to sampling error; therefore, it is a standard process to "prune" the tree back to its most reliable and meaningful nodes. To do this, we examined the deviance associated with each split, which measures the poorness of fit for the tree at each size. The empirical receiver operating characteristic curve was plotted by using probabilities of the concussion label at the terminal nodes as a measure of overall classification accuracy of the tree.

RESULTS

Three hundred forty-one children and adolescents, aged 0 (birth trauma) to 18 years, had a TBI. Among them, 300 had a recorded GCS score. Seventy-three percent of these children were categorized as having mild injuries on the basis of their GCS scores on admission to MCH. Thirty-two percent (n = 109) of the sample had a diagnosis of concussion. Figure 1 illustrates the sample size at each stage of analyses, and Table 1 shows the characteristics of the sample of children with TBI.

TABLE 1 Sample Characteristics and Key Medical Variables (N = 341)

Characteristic	Frequency	%
Gender		
Male	217	63.6
Female	124	36.4
Age at injury		
Range, y	0–18	—
Mean (SD), y	9.33 (5.32)	—
Missing data	1	—
GCS		
13–15	218	72.7
9–12	34	11.3
<8	48	16.0
Missing data	41	—
LOC		
No	211	64.3
Yes	117	35.7
Missing data	13	—
Seizures		
No	312	94.3
Yes	19	5.7
Missing data	10	—
Vomiting		
No	242	73.1
Yes	89	26.9
Missing data	10	—
Disorientation		
No	242	73.1
Yes	89	26.9
Missing data	10	—
Concussion		
Not present	227	67.6
Present	109	32.4
Missing data	5	—
Resuscitation: airway		
No intervention	260	79.0
Intervention	69	21.0
Missing data	12	—
Resuscitation: breathing		
No intervention	255	77.5
Intervention	74	22.5
Missing data	12	—
Resuscitation: circulation		
No intervention	44	13.5
Intervention	283	86.5
Missing data	14	—
CT initial taken		
No	39	11.5
Yes	301	88.5
Missing data	1	—
CT initial normal		
No	147	49.0
Yes	153	51.0
Missing data	41	—
Cause of TBI		
Mover vehicle crash	134	39.3
Fall	117	34.3
Other[a]	90	26.4

[a] Other causes of TBI include sports, assault, bicycle, and child abuse.

Concussion and Severity of Injury

Table 2 illustrates that these so-called mild injuries were statistically different from not-mild injuries (ie, the sum of moderate and severe) on key medical variables. The concussion label was significantly more likely to be applied to children with mild GCS scores when contrasted with patients with not-mild scores. However, this association was weak; >62% of the children who scored mild on the GCS were not labeled as having a concussion, and 24% of the children with moderate or severe GCS scores were labeled as having a concussion.

Proportional hazards results demonstrate that the concussion label was strongly predictive of earlier discharge from the hospital (ie, fewer days in hospital); the odds of being discharged were 1.5 times higher for children who were recorded as having a concussion (Table 3). This observation was true even if this relationship was adjusted for the GCS or for the presence of other injuries such as chest injuries or fractures.

Children labeled with a concussion also returned to school significantly sooner (ie, fewer days until school return) after discharge; the odds of returning to school sooner after discharge were 2.4 times higher for children with a concussion (Table 4). This relationship persisted after adjustment for GCS severity and the presence of other injuries.

Classification Tree for Concussion

The 7 significant predictors from Table 3 were recoded as binary predictors, and the GCS score remained coded as mild versus not mild. Intracerebral hemorrhage and subdural hematoma had similar effects on discharge time and were combined into a single binary variable. Similarly, the 3 resuscitation predictors were combined, as were the 5 types of other injuries. Although disorientation and vomiting were not significant predictors of discharge times, they were included in

TABLE 2 Comparisons Between Mild and Not-Mild Groups on Key Medical Variables ($N = 300$)

	Mild, %	Not Mild, %	χ^2, *P*
Concussion notation (yes)	37.2	23.5	.027
Vomiting (yes)	28.7	24.4	.56
Disorientation (yes)	21.3	40.2	.002
Skull Fracture (yes)	20.9	43.2	<.001
Intracerebral hemorrhage (yes)	3.7	9.9	.046
Subarachnoid hemorrhage (yes)	1.4	7.4	.015
Subdural hematoma (yes)	3.3	16.0	<.001
Resuscitation: airway (yes)	8.7	56.8	<.001
Resuscitation: breathing (yes)	11.5	55.6	<.001
Intubation (yes)	12.4	58.5	<.001
LOC (yes)	31.0	55.0	<.001
CT scan normal	60.6	29.1	<.001

the classification tree on theoretical considerations, which yielded a total of 9 predictors.

The initial partitioning resulted in a tree involving 8 of 9 predictors with 28 terminal nodes. Inspection of the deviance plot suggested the possibility of pruning this tree back to either 10 or 5 terminal nodes. The 5-node tree was chosen (illustrated in Fig 2). Of 254 patients in the sample, 34% had a concussion diagnosis. The diagnosis of concussion was significantly more likely when CT results were normal (48%) versus abnormal (20%). Thus, 2 distinct pathways to a concussion diagnosis emerged depending on the CT findings. For children with normal CT scan results, LOC was the next most predictive branch. There was a 74% probability of receiving a concussion diagnosis for those with normal CT results and LOC, whereas there was only a 34% chance of receiving a concussion label for those who did not lose consciousness. By contrast, if the CT findings were abnormal, the next most predictive branching was based on vomiting. There was very little chance (13%) of concussion diagnosis with an abnormal CT result and no vomiting, but there was a 41% chance associated with abnormal CT findings if the child had vomiting but no disorientation. It is noteworthy that GCS severity was not predictive of the concussion label after accounting for interactions among CT findings, LOC, vomiting, and disorientation.

DISCUSSION

We discovered that the concussion label is strongly predictive of earlier discharge from the hospital and earlier return to school, independent of GCS and the presence of other associated injuries. The predictive value of the concussion label suggests that its application depends on the clinical reasoning and decision-making processes of those who evaluate childhood head injuries in the emergency department and the medical staff who care for the inpatients.

As Table 2 shows, the relationship between the GCS score and concussion is relatively weak. In our cohort, children with mild GCS scores had an increased frequency of the concussion label, but

TABLE 3 Significant Predictors of Discharge Time, Cox Regression

	Unadjusted Models				Adjusted by Severity				Adjusted by Other Injuries			
	n	OR	95% CI	*P*	*n*	OR	95% CI	*P*	*n*	OR	95% CI	*P*
Severity of injury	267								266			
Mild vs not mild		0.61	0.46–0.80	<.001						0.69	0.52–0.92	.011
Cause of injury	267				267				266			
MVA vs sports[a]		1.49	1.10–2.04	.011		1.43	1.05–1.95	.024		1.00	0.70–1.43	.99
MVA vs fall		1.70	1.27–2.27	<.001		1.62	1.21–2.17	.001		1.25	0.89–1.75	.19
Medical outcomes												
Concussion	265	1.49	1.15–1.94	.003	265	1.36	1.04–1.77	.024	264	1.54	1.18–2.01	.001
LOC	259	0.73	0.57–0.94	.02	259	0.82	0.63–1.07	.15	258	0.83	0.64–1.09	.19
Intracerebral hemorrhage	265	0.52	0.30–0.88	.016	265	0.58	0.34–1.00	.048	264	0.73	0.42–1.26	.25
Subdural hematoma	265	0.56	0.35–0.89	.014	265	0.66	0.41–1.05	.081	264	0.50	0.31–0.82	.005
Resuscitation: airway	266	0.38	0.28–0.53	<.001	266	0.41	0.29–0.58	<.001	265	0.50	0.35–0.71	<.001
Resuscitation: breathing	266	0.41	0.30–0.56	<.001	266	0.45	0.32–0.62	<.001	265	0.51	0.37–0.71	<.001
Resuscitation: circulation	265	0.61	0.40–0.94	.023	265	0.69	0.45–1.06	.086	264	0.86	0.55–1.37	.53
Initial CT normal	266	1.48	1.15–1.89	.002	266	1.27	0.97–1.66	.081	265	1.60	1.24–2.06	<.001
Other injuries												
Rib	266	0.41	0.20–0.85	.015	266	0.43	0.21–0.87	.019	—	—	—	—
Pulmonary contusion	266	0.44	0.26–0.75	.003	266	0.49	0.29–0.83	.008	—	—	—	—
Hemo/pneumothorax	266	0.33	0.18–0.59	<.001	266	0.37	0.20–0.68	.001	—	—	—	—
Other chest	266	0.44	0.29–0.68	<.001	266	0.48	0.31–0.74	.001	—	—	—	—
Musculoskeletal	266	0.55	0.43–0.72	<.001	266	0.53	0.41–0.69	<.001	—	—	—	—

OR > 1 means leaving hospital sooner; OR < 1 means staying at hospital longer. MVA indicates motor vehicle crash.
[a] Includes cause of injury as sports, assault, bicycle, and child abuse.

TABLE 4 Significant Predictors of School Return Time, Cox Regression

	Unadjusted Models				Adjusted by Severity				Adjusted by Other Injuries[a]			
	n	OR	95% CI	*P*	*n*	OR	95% CI	*P*	*n*	OR	95% CI	*P*
Severity of injury	109								109			
Mild vs not mild		0.64	0.40–1.02	0.06						0.77	0.45–1.32	.34
Cause of injury	109				109				109			
MVA vs sports[b]		2.02	1.26–3.24	0.004		1.89	1.17–3.05	.009		1.79	1.01–3.17	.048
MVA vs fall		1.55	0.86–2.80	0.147		1.45	0.80–2.63	.23		1.39	0.71–2.73	.33
Medical outcomes												
Concussion	108	2.42	1.56–3.73	<0.001	108	2.26	1.44–3.54	<.001	108	2.10	1.34–3.28	.001
Resuscitation: breathing	109	0.47	0.30–0.74	0.001	109	0.49	0.29–0.82	.007	109	0.51	0.31–0.84	.007

OR > 1 means returning to school sooner; OR < 1 means staying at home longer. MVA indicates motor vehicle crash.

[a] Those that were found significant in the proportional hazards regression analysis: discharge time.

[b] Includes cause of injury as sports, assault, bicycle, and child abuse.

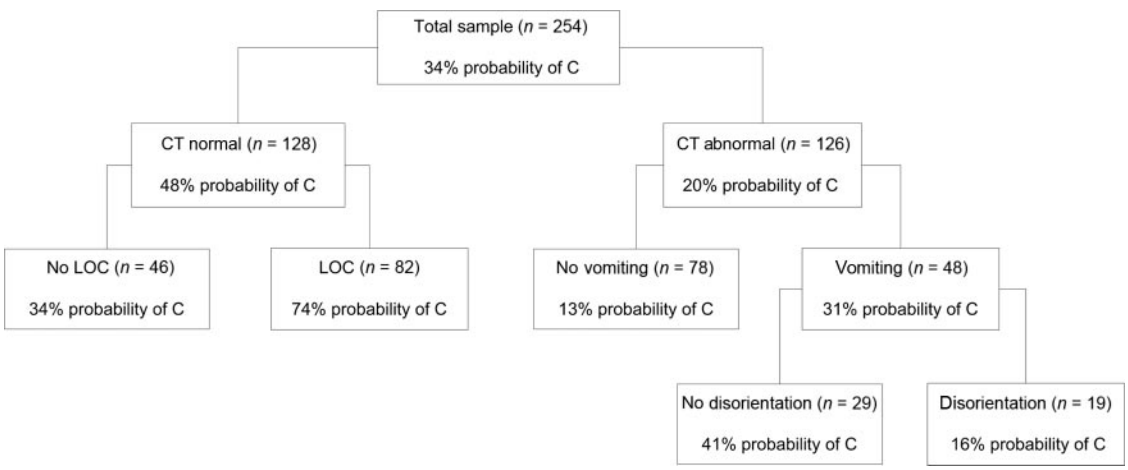

FIGURE 2

A simplified classification tree for concussion. C indicates receiving a concussion label.

the label may also be applied to more-severe injuries. In their retrospective evaluation of 242 children admitted to the emergency department with non-severe head injuries (GCS ≥ 13), Falk et al[9] found that 132 (55%) were given the diagnosis of concussion, which spanned the categories of minimal (GCS = 15), mild, and moderate. Thirty-two percent of our cohort with TBI was diagnosed with concussion, and 37% of these patients were within the mild GCS category. Other researchers have reported similar trends in which mild concussions are described as compared with more-serious concussions.[4,33] This leads one to question the use of the term as being reflective of mild injury and again supports the existence of confusion about what a concussion really is and how the term should best be used in the care of children.

Our entire cohort with TBI was admitted, and 89% of the patients received a CT scan, with 49% of the scans showing abnormal results. The largest percentage of normal CT scan results was in the mild GCS group. This potentially reflects the case mix that arose from sampling after admission to the hospital. For instance, in the study of Browne and Lam,[33] 25% of the children with concussive head injury were admitted, of which 23% had imaging performed. In a study by Dunning et al,[34] of 22 772 children with head injuries who attended emergency departments in northwest England, 98% of the patients had mild GCS scores (≥13); the rate of conducted CT scans was only 3.3%, of which 1.2% of the scans showed abnormalities. The administration of CT rates and results vary across institutions depending on the population, the type of hospital, and the guidelines for CT being administered.

In our institution, having a normal CT scan result was the greatest predictor of receiving a label of concussion. We identified combinations of clinical variables that predicted the concussion diagnosis (Fig 2). The group of children most likely to be labeled as having a concussion is those with normal CT scan results and some LOC. The chance of a concussion diagnosis is low among those patients with abnormal CT findings (20%), but among such children, the diagnosis is more likely if they also have some vomiting but no disorientation. It is important to note that the prediction tree summarizes empirical associations but does not necessarily summarize a decision rule used by clinicians. For instance, it is not necessarily the case that physicians first evaluated the CT findings and then considered LOC or vomiting when deciding how to characterize the injury.

The Canadian Paediatric Society implies through its definition that concussion is "an aberration in brain physiology and function rather than a structural injury."[10](p421) This is consistent with the recommendation made by Dunning et al[34] that CT scans are not routinely recommended in diagnosing a concussion. The population described in our study had attended an emergency department, and it was felt to be necessary to admit the children to the hospital. It was not surprising that most of the children in our sample had CT scans, and if the CT scan result was normal, it was predictive of the child receiving a concussion label. This implies a perceived need for CT evidence of no structural damage before the concussion label was applied and does suggest support of the no structural injury criteria of concussion. Although LOC is no longer a requisite for the diagnosis of concussion,[10] in our analysis, it was the next important predictor of whether the child would receive the label if the CT results were normal. A normal CT result likely implies to parents that their child has no brain injury. Is this what is intended by physicians when they apply the concussion diagnosis? It would seem that most physicians making this diagnosis with an admitted child do so to identify a situation in which the child was discovered to have no structural damage in the presence of symptoms that clearly suggest a brain injury and in which recovery is occurring quickly.

No discussion of concussion is complete without addressing sports-related concussion, which is receiving an increasing amount of attention and scientific study. Kirkwood et al[4] have provided a review of concussion as it relates to the pediatric athlete. Browne and Lam[33] in their case series of 592 children with head injuries reported that a concussive head injury was 6 times more likely to have resulted from organized sports than from other leisure activities. This result may reflect a tradition of using the term "concussion" in sports medicine. Although 12% of our cohort had sports-related head injuries, the cause of injury was not predictive of receiving the concussion label.

The evidence that concussions are underreported by young athletes and their trainers[35] supports the hypothesis that the condition of concussion may not be taken seriously enough. Our findings, both in the return-to-school data and the phenomenon we experienced during recruitment, suggest that if a child is given a diagnosis of concussion, then the family is less likely to consider it as a brain injury. This belief may have affected their decisions with respect to allowing the child's return to school. In a study that examined how beliefs about MTBI affected complaints and their persistence, Mulhern and McMillan[36] found that beliefs about the undesirability of conditions were associated with the expected outcomes.

It seems possible that giving a child the diagnosis of concussion is intended by some physicians to convey an idea of MTBI. It is also possible that parents and teachers share this understanding, because it is also predictive of a key transition after discharge (ie, school return). Because the evidence to date tells us that most children and adolescents make a full recovery from one MTBI,[13,33,37–39] is it necessary to have 2 diagnoses that, in theory, are the same but may produce different reactions to the injury?

In the words of Kirkwood et al, "the pediatric . . . concussion story remains largely untold."[4](p1367) We suggest that the label itself conveys a message and also directs outcomes. If we want to encourage full reporting with subsequent adequate management and convalescence, perhaps we should use the term "MTBI."

STUDY LIMITATIONS

Although we collected data by using a prospective standardized procedure, data from medical charts were plagued by missing information and a lack of control of the validity of measurements. Although MCH is similar to other Canadian tertiary children's facilities, the fact that this study was based in only 1 hospital may have influenced the results. Because we only included children who were admitted, our medical variables, such as the CT-scan frequency results, may seem inflated.

CONCLUSIONS

The term "concussion" is frequently used in clinical records to describe TBI. For children, the concussion label is strongly predictive of earlier discharge from the hospital and an earlier return to school, independent of the GCS score and the presence of other associated injuries. The predictive value of the concussion label suggests that it is closely tied to the clinical reasoning and decision-making processes of the emergency department medical personnel who evaluate children with head injuries and the decision-makers on the wards. Clinicians seem to treat the terms "MTBI" (as measured by the GCS) and "concussion" as 2 separate diagnostic categories when, in fact, they both reflect a mild brain injury. It may be that using more-specific descriptors of brain injury, other than concussion, could lead to a more consistent use of terminology for both clinical and research purposes.

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REFERENCES

1. Anderson T, Heitger M, Macleod AD. Concussion and mild head injury. *Pract Neurol*. 2006;6(6):342–357
2. McCrory P, Collie A, Anderson V, Davis G. Can we manage sport-related concussion in children the same as in adults? *Br J Sports Med*. 2004;38(5):516–519
3. Patel DR, Shivdasani V, Baker RJ. Management of sport-related concussion in young athletes. *Sports Med*. 2005;35(8):671–684
4. Kirkwood MW, Yeates KO, Wilson PE. Pediatric sport-related concussion: a review of the clinical management of an oft-neglected population. *Pediatrics*. 2006;117(4):1359–1371
5. Gordon KE, Dooley JM, Wood EP. Descriptive epidemiology of concussion. *Pediatr Neurol*. 2006;34(5):376–378
6. World Health Organization. *International Statistical Classification of Diseases and Related Health Problems*. 10th rev. Geneva, Switzerland: World Health Organization; 1992
7. Esselman PC, Uomoto JM. Classification of the spectrum of mild traumatic brain injury. *Brain Inj*. 1995;9(4):417–424
8. Leclerc S, Lassonde M, Delaney JS, Lacroix VJ, Johnston KM. Recommendations for grading of concussion in athletes. *Sports Med*. 2001;31(8):629–636
9. Falk A-C, Cederfjall C, von Wendt L, Klang SB. Management and classification of children with head injury. *Childs Nerv Syst*. 2005;21(6):430–436
10. Canadian Paediatric Society. Identification and management of children with sport-related concussion. *Paediatr Child Health*. 2006;11(7):420–428
11. McKinlay A, Dalrymple-Alford JC, Horwood LJ, Fergusson DM. Long term psychosocial outcomes after mild head injury in early childhood. *J Neurol Neurosurg Psychiatry*. 2002;73(3):281–288
12. Chapman SB, Nasits J, Challas JD, Billinger AP. Long-term recovery in paediatric head injury: overcoming the hurdles. *Adv Speech Lang Pathol*. 1999;1(1):19–30
13. Satz P, Zaucha K, McCleary C, Light R, Asarnow R, Becker D. Mild head injury in children and adolescents: a review of studies (1970–1995). *Psychol Bull*. 1997;122(2):107–131
14. Cantu RC, Herring SA, Putukian M; American College of Sports Medicine. Concussion. *N Engl J Med*. 2007;356(17):1787
15. Ropper AH, Gorson KC. Clinical practice: concussion. *N Engl J Med*. 2007;356(2):166–172
16. Aubry M, Cantu, R, Dvorak J, et al; Concussion in Sport Group. Summary and agreement statement of the 1st International Symposium on Concussion in Sport, Vienna 2001. *Clin J Sport Med*. 2002;12(1):6–11
17. Canadian Academy of Sport Medicine, Concussion Committee. Guidelines for the assessment and management of sport-related concussion. *Clin J Sport Med*. 2000;10(3):209–211
18. Guskiewicz KM, Bruce SL, Cantu RC, et al. National Athletic Trainers' Association position statement: management of sport-related concussion. *J Athl Train*. 2004;39(3):280–297
19. Teasdale G, Jennett B. Assessment of coma and impaired consciousness: a practical scale. *Lancet*. 1974;2(7872):81–84
20. Teasdale G, Jennett B. Assessment and prognosis of coma after head injury. *Acta Neurochir (Wien)*. 1976;34(1–4):45–55
21. Teasdale G, Knill-Jones R, van der Sande J. Observer variability in assessing impaired consciousness and coma. *J Neurol Neurosurg Psychiatry*. 1978;41(7):603–610
22. Wade DT. *Measurement in Neurological Rehabilitation*. New York, NY: Oxford University Press; 1992
23. Hall KM. Establishing a national traumatic brain injury information system based upon a unified data set. *Arch Phys Med Rehabil*. 1997;78(8 suppl 4):S5–S11
24. Brain Trauma Foundation, American Association of Neurological Surgeons, Joint Section on Neurotrauma and Critical Care. Glasgow coma scale score. *J Neurotrauma*. 2000;17(6–7):563–571
25. Sternbach GL. The Glasgow coma scale. *J Emerg Med*. 2000;19(1):67–71
26. Raimondi AJ, Hirschauer J. Head injury in the infant and toddler: coma scoring and outcome scale. *Childs Brain*. 1984;11(1):12–35
27. James HE. Neurologic evaluation and support in the child with an acute brain insult. *Pediatr Ann*. 1986;15(1):16–22
28. Holmes JF, Palchak MJ, MacFarlane T, Kuppermann N. Performance of the pediatric Glasgow coma scale in children with blunt head trauma. *Acad Emerg Med*. 2005;12(9):814–819
29. Breiman L, Friedman J, Stone CJ, Olshen RA. *Classification and Regression Trees*. Belmont, CA: Wadsworth International Group; 1984
30. Brown AW, Malec JF, McClelland RL, Diehl NN, Englander J, Cifu DX. Clinical elements that predict outcome after traumatic brain injury: a prospective multicenter recursive partitioning (decision-tree) analysis. *J Neurotrauma*. 2005;22(10):1040–1051
31. Andrews PJ, Sleeman DH, Statham PF, et al. Predicting recovery in patients suffering from traumatic brain injury by using admission variables and physiological data: a comparison between decision tree analysis and logistic regression. *J Neurosurg*. 2002;97(2):326–336
32. Choi SC, Muizelaar JP, Barnes TY, Marmarou A, Brooks DM, Young HF. Prediction tree for severely head-injured patients. *J Neurosurg*. 1991;75(2):251–255
33. Browne GJ, Lam LT. Concussive head injury in children and adolescents related to sports and other leisure physical activities. *Br J Sports Med*. 2006;40(2):163–168
34. Dunning J, Daly JP, Lomas JP, Lecky F, Batchelor J, Mackway-Jones K. Derivation of the children's head injury algorithm for the prediction of important clinical events decision rule for head injury in children. *Arch Dis Child*. 2006;91(11):885–891
35. Williamson IJ, Goodman D. Converging evidence for the under-reporting of concussions in youth ice hockey. *Br J Sports Med*. 2006;40(2):128–132
36. Mulhern S, McMillan TM. Knowledge and expectation of postconcussion symptoms in the general population. *J Psychosom Res*. 2006;61(4):439–445
37. Yeates KO, Taylor HG. Neurobehavioural outcomes of mild head injury in children and adolescents. *Pediatr Rehabil*. 2005;8(1):5–16
38. Carroll LJ, Cassidy JD, Peloso PM, et al. Prognosis for mild traumatic brain injury: results of the WHO Collaborating Centre Task Force on Mild Traumatic Brain Injury. *J Rehabil Med*. 2004;36(suppl 43):84–105
39. Thompson MD, Irby JW Jr. Recovery from mild head injury in pediatric populations. *Semin Pediatr Neurol*. 2003;10(2):130–139