

Establishment of a multidisciplinary concussion program: impact of standardization on patient care and resource utilization

Clinical article

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Object. Recent legislation and media coverage have heightened awareness of concussion in youth sports. Previous work by the authors' group defined significant variation of care in management of children with concussion. To address this variation, a multidisciplinary concussion program was established based on a uniform management protocol, with emphasis on community outreach via traditional media sources and the Internet. This retrospective study evaluates the impact of standardization of concussion care and resource utilization before and after standardization in a large regional pediatric hospital center.

Methods. This retrospective study included all patients younger than 18 years of age evaluated for sports-related concussion between January 1, 2007, and December 31, 2011. Emergency department, sports medicine, and neurosurgery records were reviewed. Data collected included demographics, injury details, clinical course, Sports Concussion Assessment Tool-2 (SCAT2) scores, imaging, discharge instructions, and referral for specialty care. The cohort was analyzed comparing patients evaluated before and after standardization of care.

Results. Five hundred eighty-nine patients were identified, including 270 before standardization (2007–2011) and 319 after standardization (2011–2012). Statistically significant differences ($p < 0.0001$) were observed between the 2 groups for multiple variables: there were more girls, more first-time concussions, fewer initial presentations to the emergency department, more consistent administration of the SCAT2, and more consistent supervision of return to play and return to think after adoption of the protocol.

Conclusions. A combination of increased public awareness and legislation has led to a 5-fold increase in the number of youth athletes presenting for concussion evaluation at the authors' center. Establishment of a multidisciplinary clinic with a standardized protocol resulted in significantly decreased institutional resource utilization and more consistent concussion care for this growing patient population.
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KEY WORDS • concussion • standardization • implementation analysis • trauma

HIGHTENED awareness of the significance of pediatric sports-related concussions has transformed the perception and management of this injury in recent years.^{2,8,9} Both the medical community and the media have increasingly recognized that sports-related concussions affect a large number of children and youths, with the potential for long-term negative sequelae in the developing brain.^{2,7–9,114} The paradigm of concussion management has also changed relatively rapidly. Previously, concussions were seen as acute, self-limiting injuries. Today concussions are treated as an injury with potential long-term implications that requires prompt

diagnosis, management, and extended rehabilitation.^{2,8} Concurrently, public education initiatives and recent state legislation requiring medical evaluation before return to play (RTP) have increased the numbers of youths seeking sports-related concussion evaluation.^{3,6,15} These changes have challenged the medical community to develop guidelines and efficient care systems to evaluate these youths in a timely fashion, follow their outcomes over time, and prospectively collect data regarding possible long-term effects of concussion.

In the US, a wide variety of professionals commonly evaluate pediatric sports-related concussions. Certified

Abbreviations used in this paper: RTP = return to play; RTT = return to think; SCAT2 = Sports Concussion Assessment Tool-2.

This article contains some figures that are displayed in color online but in black-and-white in the print edition.

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athletic trainers, sports medicine physicians, general pediatricians, orthopedic surgeons, neurologists, neurosurgeons, and neuropsychologists are often consulted.¹² As a result, there is often variation from institution to institution and among disciplines regarding concussion management. In 2010, to address this issue within our own institution, faculty representing Emergency Medicine, Sports Medicine, Pediatric Neurosurgery, Physical Medicine and Rehabilitation, and Neuropsychology formed the Children's of Alabama Concussion Task Force. The task force took on the charge of defining how each service managed patients with concussion and looked to identify ways to streamline processes and use dedicated resources more efficiently. We hypothesized that across this wide spectrum of medical professionals, there was also significant variation in evaluation and management practices for pediatric sports-related concussions. We sought to characterize this variation in care, and then implement a standardized, multidisciplinary management program derived from the latest evidence-based practice recommendations.

Building upon the challenges identified (Table 1) and charged with improving the quality of pediatric sports-related concussion management at our institution, the task force put into action solutions by: 1) implementing a multidisciplinary concussion management protocol (Fig. 1); 2) developing standardized discharge instructions for use across disciplines; 3) creating a dedicated multidisciplinary Sports Concussion Clinic; and 4) facilitating media attention and community education initiatives through collaboration with the Alabama State High School Association and the Alabama Head Injury Foundation.

The Children's of Alabama Concussion Task Force Management Guidelines (Fig. 1) depict an organized evaluation progression through the various medical specialties involved in concussion care. Guidelines for diagnosis and management of children with sports-related concussion were based on the 2008 Zurich Consensus Statement on Concussion in Sport and standardized for all departments, including Emergency Medicine, Neurosurgery, and Sports Medicine. Sports Medicine and their network of athletic trainers serve as the hub of referral, evaluation, and RTP supervision. The Sports Concussion Clinic is housed in the offices of Sports Medicine. School-based athletic trainers refer youths suffering their first or second concussion to the Sports Concussion Clinic, where they are evaluated within the week. At the discretion of the on-site trainer, youths may also be referred to the Emergency Department on the night

of the injury if warranted. If the Emergency Department evaluation shows abnormal brain injury or concomitant spine injury, neurosurgery is consulted. If the Emergency Department evaluation is consistent with the sole diagnosis of concussion, the youth is referred back to the hub of the Sports Concussion Clinic for administration of the Sports Concussion Assessment Tool-2 (SCAT2), evaluation for the need of referral to neuropsychology or rehabilitative medicine, and supervision of RTP following the 2008 Zurich Consensus Guidelines. This protocol was complemented by the implementation of a standardized intake sheet to capture additional demographic and situational data at the initial visit, standardized discharge instructions for use at each point of contact, and uniform ICD-9 coding across each Concussion Task force department.

Over a 2-year period, the task force conducted an implementation study whereby we were able to identify variation and gaps in the care of concussion patients, established a standardized protocol for management, and successfully implemented a dedicated sports concussion clinic to serve our community. The next challenge was to conduct a retrospective study to determine how effective our solutions were in the short run. In this paper we present our experience, quantifying the significant variation in management of pediatric sports-related concussion prior to protocol standardization, as well as the impact of an institution-wide protocol on patient care and institutional resource utilization.

Methods

Study Design

We conducted a retrospective cohort study of pediatric patients aged 0–18 years who were evaluated for sports-related concussions at Children's of Alabama between January 1, 2007, and December 31, 2011. Based on guidelines from the 2008 Zurich Consensus Statement on Concussion in Sport, concussion was defined as the rapid onset of transient neurological impairment or clinical symptoms following a direct or indirect blow to the head or body, with no abnormality present on neuroimaging studies.¹¹ Within our cohort, we identified prestandardization and poststandardization groups, separated by the opening of the Sports Concussion Clinic on August 3, 2011. The prestandardization group contained patients with sports-related concussions diagnosed from January 1, 2007, to August 2, 2011.

TABLE 1: Challenges identified and solutions implemented by the multidisciplinary concussion management task force

Retrospective Study Challenges	Concussion Task Force Solutions
variation in clinical pathway	standardized referral protocol throughout departments, encompassing care from initial injury until RTP
variation in evaluation & record-keeping	standardized intake sheet developed to capture additional demographic & situational data at the initial visit
lack of & variation w/in discharge instructions	standardized discharge instructions developed for use at each point of contact
variation in coding (8 possible ICD-9 codes identified)	each Concussion Task Force department agreed to use the ICD-9 code for unspecified sports-related concussions (850.9)
lack of education & misinformation about concussions for patient families	public service announcements developed, educational programs conducted, & community tools created

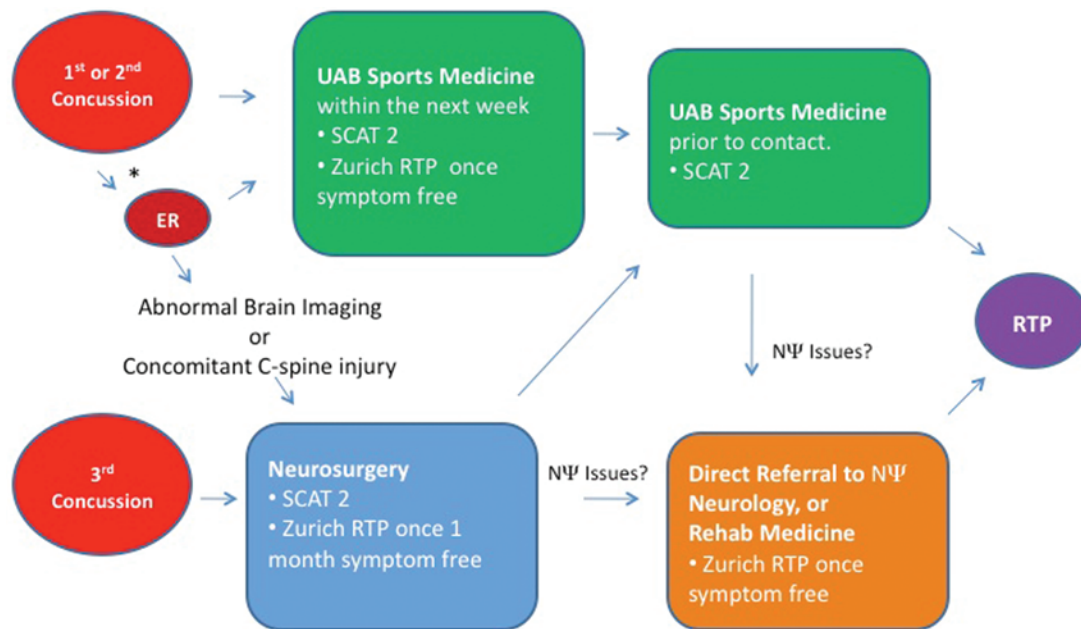


Fig. 1. Institution-wide flow diagram of concussion referral and management following standardization effort. Asterisk = Emergency room (ER) referral on night of concussion at discretion of onsite trainer. C-spine = cervical spine; NΨ = Neuropsychology; UAB = University of Alabama, Birmingham..

The poststandardization group contained concussions diagnosed from August 3, 2011, to January 31, 2011. The 2 patient groups were compared to investigate medical evaluation characteristics for pediatric sports-related concussions. The University of Alabama, Birmingham, Institutional Review Board approved the study.

Cohort

Pediatric patients who were evaluated for sports-related concussions at Children's of Alabama were identified for inclusion in the prestandardization group by queries of records in the departments of Sports Medicine, Emergency Medicine, and Pediatric Neurosurgery. The poststandardization group included patients evaluated in the Sports Concussion Clinic, the inclusion of which differentiated the pre- and poststandardization groups. After all concussion diagnoses from 2007 to 2011 were identified within the above divisions, the medical record number of each patient was searched in the general Children's of Alabama record system to identify all other medical evaluations, imaging studies, patient instructions, and/or follow-up recommendations related to the concussion injury in question.

The diversity of records systems among departments at Children's of Alabama required individualized approaches for each department to identify patients for inclusion. For example, Emergency Medicine identified eligible patients in their internal records through their injury reporting system. The injury reporting system was queried for sports-related injuries, and patients with a chief complaint of head injury or concussion were selected for chart review. In comparison, from 2007 to 2011, Sports Medicine used paper charts, and uniformly applied the ICD-9 code 850.9 (concussion, unspecified) for all concussion diagnoses. Patients were identified through a query of ICD-9 codes in the billing department, with

charts containing the ICD-9 code 850.9 selected for further review. Pediatric Neurosurgery identified patients for chart review through a query of their internal database for all procedures and visits with a concussion-related ICD-9 code (850.0–850.x and 850.9). The Sports Concussion Clinic uniformly applied the ICD-9 code 850.9 for all concussion diagnoses, and all charts containing the ICD-9 code 850.9 were selected for review. During chart review, only pediatric patients with a diagnosed sports-related concussion were selected for inclusion in the cohort.

Variables Measured

Patient-specific, injury-specific, and medical evaluation-specific data were extracted through chart review and recorded in a central database used for analysis. These variables are summarized in Table 2.

Statistical Analysis

We conducted a test for normality and found our cohorts followed a normal distribution; therefore parametric statistics were conducted. Univariate analysis and descriptive statistics, using the t-test and chi-square test, were performed. Analysis of variance was used to test the differences between the pre- and postprotocol groups, and multiple regression analysis was conducted to evaluate the relationship of the variables in both our pre- and postprotocol cohorts. Statistics were run using the statistical program SAS (version 9.2). All statistical tests were 2-tailed, with $p < 0.05$ selected a priori as the level of significance.

Results

From 2007 to 2011 we identified 589 unique pediatric sports-related concussions (suffered by 586 patients)

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TABLE 2: Data points measured during chart review

Patient Specific	Injury Specific	Evaluation Specific
demographics	date of injury	date of evaluation
number of prior concussions	sport	days from concussion to evaluation
months since most recent concussion	mechanism of impact†	Children's of Alabama department of evaluation
other comorbidities identified by 2008 Zurich Consensus Statement as concussion modifiers*	circumstance‡	previous evaluations
	initial symptoms§	symptom resolution prior to evaluation
		primary ICD-9 code related to head injury
		head imaging obtained
		use of standardized concussion evaluation tools, such as the SCAT2, & scores
		instructions given to patient¶
		follow-up referrals given
		follow-up visits attended

* 2008 Zurich Consensus Statement on Concussion in Sport concussion modifiers: migraine, depression or other mental health disorders, attention deficit hyperactivity disorder, learning disabilities, and sleep disorders.

† Mechanisms grouped as: helmet to helmet, unspecified head-on collision with player, head to turf or field, head to wood floor or concrete, head to ball, head to player's limb, head to surroundings or equipment, or unrecorded.

‡ Game, practice, or recreation.

§ Headache, dizziness, nausea, vomiting, visual disturbances, hearing disturbances, concentration difficulty, academic difficulty, slurred speech, mood disturbances, fatigue, sleep disturbances, memory loss, confusion, and coordination difficulty.

¶ Instructions regarding further outpatient follow-up, RTP, and return to think (RTT).

in children aged 0–18 years who were diagnosed at Children's of Alabama. The 3 patients who presented with 2 concussions each were analyzed as unique concussions because in each youth the concussions occurred at least 1 month apart and the second injury occurred after the previous concussion had symptomatically resolved. There were 270 sports-related concussions diagnosed from January 1, 2007, to August 2, 2011, which constituted the prestandardization group. There were 319 sports-related concussions diagnosed from August 3, 2011, to December 31, 2011, which constituted the poststandardization group.

Prestandardization Group

The prestandardization group contained 270 concussions, occurring in 227 boys (84.1%) and 43 girls (15.9%; Table 3). The average age of injury (\pm SD) was 13 ± 3 years. The most common age group was youths over 14 years old (49.6%; range 5–18 years old). The most frequent sport was organized youth football (49.4%), followed by baseball or softball (17.1%) and basketball (16%; Table 4). The most frequent mechanism of injury was helmet-to-helmet collisions (20.7%), followed closely by the more general category of head-on collisions (10.2%). Concussions occurred most often at games (53.4%) compared with practice or recreation.

Characteristics of medical evaluations in the prestandardization cohort often varied significantly across the medical specialty to which the patient first presented. Two hundred sixteen concussions (80.0%) were initially evaluated by Emergency Medicine, compared with 52 (19.3%) initially evaluated at Sports Medicine, and 2 first evaluated at Neurosurgery (0.7%; Table 5). Of the

216 patients who were initially evaluated by Emergency Medicine, 180 were evaluated within hours of the event, compared with the patients initially evaluated by Sports Medicine in which only 1 of the 52 patients were evaluated within hours of the event ($p < 0.0001$). Compared with Sports Medicine evaluations, patients initially evaluated for sports-related concussions by Emergency Medicine were more likely to receive head imaging at their initial visit ($p = 0.0003$). Patients initially presenting to Emergency Medicine received head CTs more often than those initially presenting to Sports Medicine (48% and 19%, respectively; $p < 0.0001$). Only 5 patients received an MRI in the prestandardization group and those patients were initially evaluated in the Sports Medicine clinic.

The SCAT2 was endorsed by the Consensus Statement on Concussion in Sport from the 3rd International Conference on Concussion in Sport held in Zurich in November 2008. In the prestandardization group (patients treated between 2007 and 2011), neither Sports Medicine nor Emergency Medicine recorded use of the SCAT2 before 2009. Emergency Medicine did not record use of the SCAT2 during concussion evaluations, while Sports Medicine used the SCAT2 in 36.5% of patients, with rates sharply increasing from 2010 to 2011 (variation between Emergency Medicine and Sports Medicine: $p < 0.0001$).

Return-to-play instructions were another area of variation in medical care of the prestandardization group. The Summary and Agreement Statement of the 1st International Symposium on Concussion in Sport, held in Vienna 2001, was published in multiple journals in 2002, and endorsed graduated RTP guidelines following a concussion. These guidelines continue to be endorsed by the 2008 and 2012 Zurich consensus statements. While

TABLE 3: Demographic characteristics before and after standardization

Variable	Before Standardization (n = 270)	After Standardization (n = 319)	p Value
mean age \pm SD (yrs)	13.0 \pm 3.1	13.6 \pm 3.9	
age in yrs (%)			0.3
<8	18 (6.7)	13 (4.1)	
8–10	38 (14.1)	35 (11.0)	
11–12	16 (5.9)	25 (7.8)	
13–14	64 (23.7)	92 (28.8)	
>14	134 (49.6)	154 (48.3)	
sex (%)			<0.0001
male	227 (84.1)	218 (68.3)	
female	43 (15.9)	101 (31.7)	
race/ethnicity (%)			<0.002
white	160 (59.3)	219 (68.6)	
African American	107 (39.6)	79 (24.8)	
others	3 (1.1)	8 (2.5)	
unknown	0 (0)	13 (4.1)	
insurance (%)			<0.0001
public	104 (38.5)	83 (26.0)	
private	155 (57.4)	233 (73.0)	
self-pay	11 (4.1)	1 (0.3)	
unknown	0 (0)	2 (0.6)	

both Emergency Medicine and Sports Medicine consistently recorded discharge instructions for patients, Sports Medicine was significantly more likely to have recorded specific instructions for graduated RTP in the discharge instructions (100%) compared with Emergency Medicine (65%; $p = 0.04$). Additionally, Sports Medicine recorded discussion of graduated (RTT) guidelines (which refers to a child's resumption of schooling) with patients and

families 70% of the time compared with 12% for patients evaluated by Emergency Medicine ($p < 0.0001$). Forty-eight children (17.8%) in the prestandardization group attended at least 1 follow-up visit for concussion management at Children's of Alabama.

Poststandardization Group

There were 319 sports-related concussions diagnosed

TABLE 4: Injury characteristics before and after standardization*

Variable	Before Standardization	After Standardization	p Value
sport	(n = 269)	(n = 259)	<0.0002
football	133 (49.4)	129 (49.8)	
basketball	43 (16.0)	31 (12.0)	
baseball or softball	46 (17.1)	17 (6.6)	
soccer	15 (5.6)	27 (10.4)	
others	32 (11.9)	55 (21.2)	
mechanism of impact	(n = 266)	(n = 314)	<0.0004
helmet to helmet	55 (20.7)	88 (28.0)	
head-on collision	27 (10.2)	11 (3.5)	
head to ground/floor	73 (27.4)	110 (35.0)	
other	111 (41.7)	105 (33.4)	
circumstance	(n = 251)	(n = 272)	<0.0001
game	134 (53.4)	98 (36.0)	
practice	57 (22.7)	86 (31.6)	
recreation	2 (0.8)	24 (8.8)	
other	58 (23.1)	64 (23.5)	

* All data given as number of patients (%) unless otherwise indicated.

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TABLE 5: Clinical characteristics before and after standardization*

Variable	Before Standardization n = 270	After Standardization n = 319	p Value
days to first evaluation (%)			<0.0001
<1	181 (67.0)	53 (16.6)	
1–3	54 (20.0)	66 (20.7)	
>3–7	23 (8.5)	68 (21.3)	
>7	12 (4.4)	132 (41.4)	
department at which patient first presented (%)			<0.0001
emergency medicine	216 (80.0)	74 (23.2)	
sports medicine	52 (19.3)	245 (76.8)	
pediatric neurosurgery	2 (0.7)	0 (0.0)	
primary ICD-9 related to concussion diagnosis (%)			<0.0001
850.9	52 (19.3)	301 (94.4)	
others	218 (80.7)	18 (5.6)	
imaging obtained (%)			<0.0001
yes	114 (42.2)	78 (24.5)	
no	156 (57.8)	241 (75.5)	

* All clinical characteristics related to Children's of Alabama.

in the poststandardization group, in 218 boys (68.3%) and 101 girls (31.7%; Table 3). Compared with the entire year prior, the poststandardization group represented a 5-fold increase in the number of annual concussion evaluations and a 40% increase in the number of girls. The poststandardization group was differentiated from the prestandardization group by the presence of both an institution-wide multidisciplinary concussion management program with a dedicated sports concussion clinic, and heightened public awareness of the significance of sports concussions with legislation requiring physician clearance for RTP.

The average age of injury in the poststandardization group was 13.6 ± 3.9 years. Football remained the most frequent sport (49.8%; Table 4). The most frequent mechanism of injury remained helmet to helmet (28%), followed by head to wood floor or concrete ground (35.0%). Games remained the most common circumstance for injury (36%) compared with practice or recreation (31.6% and 8.8%, respectively).

In the poststandardization group, 74 youths initially presented to the Emergency Department with sports-related concussions, compared with 245 youths who initially presented to the Sports Concussion Clinic at Sports Medicine for evaluation (Table 5). Although the percentage of patients receiving a CT scan at initial presentation to Sports Medicine remained stable, the percentage of patients receiving a CT scan at initial presentation to Emergency Medicine dropped from 48% to 9.5% ($p < 0.0001$). While we did not see a change in practice patterns in Emergency Medicine with regards to the use of SCAT2, there was an overall increase in SCAT2 use for the poststandardization group, with 74% of patients seen in the Sports Medicine Concussion Clinic evaluated using the SCAT2. Of the 218 patients for whom a concussion was diagnosed and the SCAT2 score was recorded, the mean postconcussive SCAT2 score was 79.47 ± 18.92 . Discharge instructions

specifically describing graduated RTP guidelines were in the medical records of 100% of patients initially evaluated by both Emergency Medicine and the Sports Concussion Clinic. Of the children in the poststandardization group, 65.2% attended at least 1 follow-up visit for concussion management at Children's of Alabama.

Comparisons Before and After Standardization

Comparisons between the 2 groups are shown for patient demographics in Table 3, for injury characteristics in Table 4, and for medical evaluation characteristics in Table 5.

Compared with the prestandardization group, the poststandardization group had significantly more girls (31.7% vs 15.9%, respectively; $p < 0.0001$), more white children (71.6% vs 59.3%, respectively; $p < 0.002$), and more children with private insurance (73.5% vs 57.4%, respectively; $p < 0.0001$). There was no significant difference in the age distribution of children presenting with concussion. There was also no significant difference in the rate of children with comorbidities identified by the 2008 Zurich Consensus Statement on Concussion in Sport as concussion modifiers.

Football remained the most common sport of injury (49.4% in the prestandardization group vs 49.8% in the poststandardization group) and helmet-to-helmet impacts remained the most common mechanism of injury (20.7% in the prestandardization group vs 28% in the poststandardization group). Medical evaluation characteristics, however, were markedly affected. The poststandardization group had significantly fewer initial presentations to the Emergency Department compared with the prestandardization group (23.2% vs 80.0%, respectively; $p < 0.0001$), with the majority of youths in the poststandardization group initially presenting to the Children's of Alabama Sports Concussion Clinic at Sports Medicine.

There was also significantly less imaging performed at the initial evaluation in the poststandardization group (24.5% vs 42.2%, respectively; $p < 0.0001$) and more consistent administration of the SCAT2 (73.4% vs 12.2%, respectively; $p < 0.0001$).

Instructions for patients regarding RTP and RTT were also significantly increased in the poststandardization group compared with the prestandardization group. Discharge instructions that provided clear RTP guidelines increased from 76% overall before standardization to 100% after standardization ($p < 0.001$), and instructions on RTT increased from 24% to 98%, respectively ($p < 0.001$).

Discussion

The true epidemiology of pediatric sports-related concussions has proven difficult to capture due to historical underreporting of cases and the variety of medical providers involved in the assessment and management of athletes.^{7,8,13} The clear trend, however, has been a national increase in concussions evaluated since 2000.^{3,6} Annual summary reports of the National High School Sports-Related Injury Surveillance Study indicate that estimates of the annual number of sports-related concussions reported in all high school athletes increased from 133,162 in the 2005–2006 school year to 237,931 in the 2010–2011 school year.^{4,5} Concussion moved from the fourth most commonly reported category of injury (behind strain/sprain, contusion, and fracture), accounting for 9.1% of all injuries in 2005–2006, to the most commonly reported injury category, and 20.0% of all injuries in 2011–2012.^{4,5} Of the 1056 concussions recorded in the 2009–2010 High School Reporting Information Online, only 1.6% were evaluated by Emergency Department physicians.¹² Other than the High School Reporting Information Online, Emergency Department reporting is a major source of data for national estimates. The Centers for Disease Control and Prevention reported that from 2001 to 2009, the estimated number of annual sports and recreation-related nonfatal traumatic brain injury-related visits to emergency departments by persons aged ≤ 19 years increased 62%, from 153,375 in 2001 to 248,418 in 2009.³

Concurrently with increased concussion evaluations, concussion management recommendations and requirements have changed significantly over the past 20 years.⁴ “Getting your bell rung” or being “dinged” once referred to head impact injuries that athletes were encouraged to “shake off” and quickly get back in the game.² In the 1990s, concussion grading scales were developed to guide management decisions. In most scales, athletes with Grade I concussion were allowed to RTP if they remained asymptomatic for 15–20 minutes.² In 2001, the Summary and Agreement Statement of the 1st International Symposium on Concussion in Sport changed course and recommended that when a player showed any symptoms or signs of concussion, the player should not be allowed to RTP in the current game or practice. When asymptomatic, the athlete was then recommended to follow a supervised rehabilitation protocol consisting of gradual incremental increases in exercise duration and intensity¹ prior to their RTP. The 2nd and 3rd International Confer-

ences on Concussion in Sport reaffirmed this graduated RTP protocol.^{10,11}

Beginning in 2009, growing media attention to sports-related concussions and public awareness led to legislative response, with Washington State being the first to pass youth sports-related concussion legislation in 2009.¹⁷ As of March 5, 2013, 43 states have passed similar youth sports concussion legislation, with legislation pending in 4 states (Arkansas, Tennessee, West Virginia, and South Carolina), and only 3 states without legislation (Georgia, Mississippi, and Montana).¹⁶

Alabama state legislation includes requirements for 1) education of youth athletes and their parents or guardians regarding the nature and risk of concussion and brain injury, including continuing to play after a suspected concussion or brain injury; 2) annual training of coaches to recognize the symptoms of a concussion and when to seek proper medical treatment for a person suspected of having a concussion; and 3) removal of any youth athlete suspected of sustaining a concussion or brain injury in a practice or game from participation. The athlete may not RTP until he or she is evaluated by a licensed physician and receives written clearance from a licensed physician.

The evolving concussion management paradigm, increase in public awareness, and signing of concussion legislation in Alabama on June 9, 2011, all contributed to a 5-fold increase in concussion evaluations in our cohort from August 3, 2011, to December 31, 2011, compared with the entire year prior. After adoption of the protocol, we observed significantly more consistent care of children with concussions evaluated at our institution, with fewer initial presentations to the Emergency Department, less imaging performed at initial presentation, more consistent use of the SCAT2 assessment tool, and near-universal distribution of discharge instructions regarding RTP and RTT guidelines. The success of this effort was the direct result of close collaboration over many months among multiple clinical services, hospital administration, and community outreach efforts by the hospital.

The results of this study should be interpreted with respect to its limitations. As a single-site retrospective study, we cannot estimate the statewide incidence of concussion nor quantify the number of children evaluated for concussion outside our institution. Due to variation in record systems, inclusion of the relatively few patients evaluated and managed through departments at Children’s of Alabama outside Emergency Medicine, Sports Medicine, and Neurosurgery was not possible. Although the pre- and post-standardization cohorts were not evaluated over the same time span, we believe that the similar cohort size allows for appropriate analysis. However, given the difference in time periods, we cannot definitely state that results in the long run would show significant association with standardization of care; therefore we plan on conducting additional analysis once a more comparable time frame exists. Also, some issues of comparability between the prestandardization and poststandardization groups may create other limitations: knowledge of recommendations for graduated RTP and tools such as the SCAT2 were increasingly disseminated over time, in addition to the institution-specific Concussion Task Force solutions implemented. Although

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there is encouraging precedent in other medical diagnoses, the question remains whether and how much protocol-driven, consistent care for sports concussion leads to improved outcomes, and is the subject of ongoing research at our center.

Conclusions

In 2011 our institution observed a 5-fold increase in the annual number of sports concussions referred for management compared with the prior year, likely secondary to increased public awareness and recently passed statewide legislation requiring medical evaluation. Coordinated care among Pediatric Neurosurgery, Sports Medicine, and Emergency Medicine was crucial as we used best practice standards from all disciplines to implement a clinical pathway that would best serve our patients. Adoption of an institutional protocol led to more uniform evaluation with the SCAT2, more consistently supervised RTP and RTT based on the 2008 Zurich Guidelines, more appropriate referral of children for neuropsychological follow-up, as well as decreased hospital resource utilization, Emergency Department visits, and imaging. Ongoing research includes a comparative effectiveness analysis of long-term outcomes as well as the cost effectiveness and economic impact of improved resource utilization.

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Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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