After-Hours Call Center Triage of Pediatric Head Injury
Outcomes After a Concussion Initiative

Jennifer N. Fishe, MD, Anthony A. Luberti, MD,†‖ Christina L. Master, MD,‡‖ Roni L. Robinson, RN, MSN, CRNP,‡ Matthew F. Grady, MD,‡‖ Kristy B. Arbogast, PhD,§‖ and Mark R. Zonfrillo, MD, MSCE¶*

Objective: The aim of the study was to characterize referral patterns and medical outcomes of children with head injury triaged by an after-hours call center of a large urban pediatric network, both before and after an institutional concussion initiative. The initiative included a revised call center triage algorithm referring patients with a suspected concussion to see a primary care provider (PCP) within 24 hours, concussion-specific continuing education for medical providers, and a new concussion information Web site.

Methods: Patients aged 5 to 18 years with head injury using the after-hours call center were identified by retrospective review of electronic medical records before (2011) and after (2012) the initiative. A random 50% sample was taken from each year for further analysis.

Results: A total of 127 and 159 eligible patient encounters were randomly selected from 2011 to 2012, respectively. From 2011 to 2012, PCP referrals significantly increased from 7% (95% confidence interval [CI], 4%–13%) to 38% (95% CI, 31%–45%), $P < 0.001$. Concussion diagnoses also significantly increased from 35% (95% CI, 27%–44%) to 58% (95% CI, 50%–66%), $P < 0.001$. Emergency department referrals and head computed tomography scans decreased but the differences were not statistically significant. No patients had intracranial injury on computed tomography. Most injuries were not sports related.

Conclusions: After an institutional concussion initiative including implementation of a revised head trauma telephone triage algorithm, more head injuries were evaluated by PCPs and more concussions were ultimately diagnosed without an increase in emergency department referrals. Clinicians can benefit from continuing education and infrastructure to aid in initial concussion diagnosis and management.

Key Words: after hours, concussion, head injury, triage

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Every year in the United States, an estimated 1.5 million children sustain traumatic brain injuries (TBIs) and one third are evaluated in an emergency department (ED).[1,2] The American Association of Neurologic Surgeons define TBI as a blow or jolt to the head or penetrating head injury that disrupts the normal function of the brain.[1] Concussion, a mild form of TBI, is increasingly recognized and accounts for 150,000 to 240,000 annual pediatric ED visits.[3,4] Concussion is a complex pathophysiologic process induced by traumatic biomechanical forces resulting in impairment in neurologic function without radiographic abnormality.[5] Prompt diagnosis of concussion, institution of cognitive and physical rest, and gradual return to school and activity are crucial to recovery.[6,7]

Given the incidence of pediatric TBI, head injury is a frequent chief complaint to after-hours telephone call centers.[8] Primary care providers (PCPs) use call centers to manage patient calls after business hours.[9] Previous studies have validated these centers as a safe form of patient triage.[10–12] After-hours call centers can produce significant cost savings for nonurgent conditions because many parents report that they otherwise would have sought emergent care.[13] For patients with head injury, after-hours telephone triage can refer those at high risk for intracranial injury to an ED, those with suspected concussion to their PCP, and those with minor head trauma to home care. This study sought to evaluate the referral patterns and medical outcomes of pediatric patients with head injury triaged by the after-hours call center of a large, urban primary care network before and after an institutional concussion initiative.

METHODS

Study Design

Data were collected by retrospective review of our institution's electronic medical records (EpicCare; Epic Systems Corp, Verona, Wis). Our institutional review board approved the study.

Study Setting and Population

Our institution's after-hours call center annually receives approximately 100,000 telephone calls from 54,000 patients of 29 primary care clinics in the greater Philadelphia area. Telephone calls are forwarded from primary care clinics to the after-hours call center between 5:00 P.M. and 9:00 A.M. on weekdays and at all times on Saturday, Sunday, and hospital holidays. The nurses who staff the after-hours call center are specially trained in telephone triage. These nurses triage patients by following computer-based telephone triage algorithms.

Institutional Concussion Initiative

In 2012, our institution launched a comprehensive, institution-wide initiative to promote updated concussion management practices. The initiative included continuing medical education on concussion diagnosis and management for PCPs within our care network (May–June 2012), creation of a standardized clinical decision support tool for outpatient concussion diagnosis and treatment (June 2012), redesign of our institution's public concussion information Web site (June 2012), and standardized patient and

From the *Division of Pediatric Emergency Medicine, Johns Hopkins Hospital, Baltimore MD; †After Hours Program and Pediatric Research Consortium, Center for Biomedical Informatics, ‡Sports Medicine and Performance Center, and §Division of Emergency Medicine and Center for Injury Research and Prevention, The Children's Hospital of Philadelphia; ‖Department of Pediatrics, Perelman School of Medicine at the University of Pennsylvania, Philadelphia, PA; and ¶Department of Emergency Medicine and Injury Prevention Center, Alpert Medical School of Brown University, Providence, RI.

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Reprints: Jennifer N. Fishe, MD, Division of Pediatric Emergency Medicine, Johns Hopkins Hospital, 1800 Orleans St, Suite G-1509, Baltimore MD 2187 (e-mail: jnfishe@gmail.com).

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family education materials (ie, discharge instructions) for the primary care and ED settings (June 2012).

In late August of 2012, the after-hours call center head trauma triage algorithm was revised. Patients with symptoms of a concussion but without signs of intracranial injury were referred to see a PCP within 24 hours for initial evaluation and management. Previously, these patients would have been referred to an ED. These patients were also instructed to follow cognitive rest while awaiting their PCP appointment. The algorithm's questions designed to identify patients with signs of intracranial injury (seizure, loss of consciousness greater than 1 minute, high risk mechanism, severe headache, penetrating trauma, etc) remained unchanged, and all these patients were referred to an ED. There was no change in the home care recommendations for patients with minor head trauma (superficial hematomas, abrasions, or lacerations not requiring repair).

Study Protocol

Our institution's electronic medical record system (EpicCare) was queried for after-hours call center encounters. Patients aged 5 to 18 years with head trauma were identified by searching for encounters that used the head trauma after-hours telephone triage algorithm or that had a keyword "concussion" in the note. The following 2 periods were analyzed: from September 01, 2011, to December 31, 2011 before the institution-wide initiative and from September 01, 2012, to December 31, 2012 after the initiative. From each period, a 50% random sample was selected for further abstraction.

If more than 1 call was made regarding the same injury, the sentinel call was identified and data abstracted from this first call. Charts were excluded if there was no head trauma or if the injury occurred more than 7 days before the first telephone encounter, because these calls did not represent initial injury triage. Data extracted were stored in Research Electronic Data Capture (REDCap, Nashville, Tenn), a secure web-based application hosted at our center for biomedical informatics.[14]

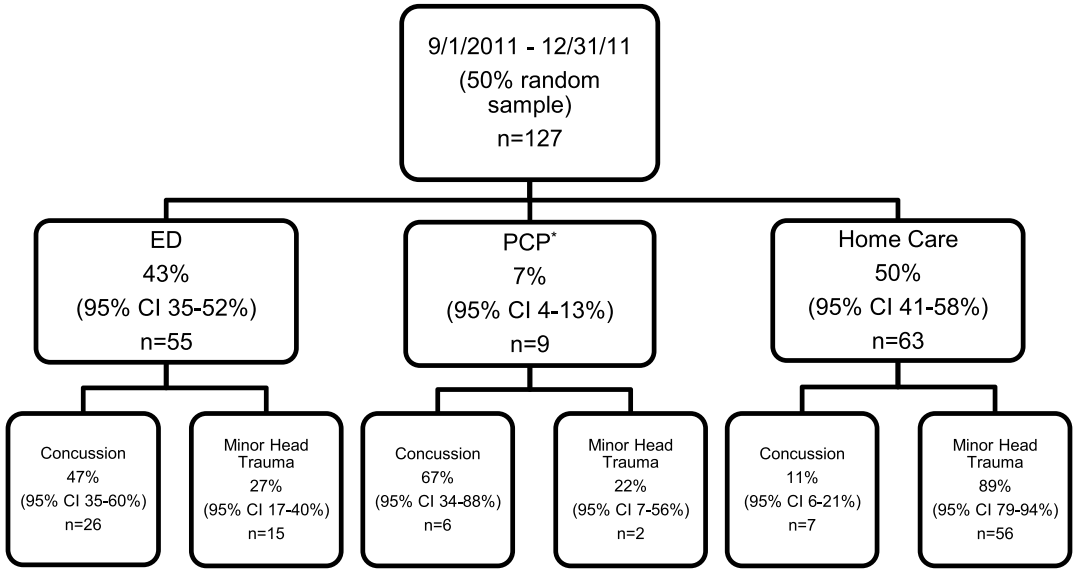
Measurements

Every encounter related to the head injury in each patient's medical record was manually reviewed to abstract the following data: telephone triage referral recommendation, first presentation to medical care, second presentation for the same injury (when applicable), radiographic imaging, and final medical diagnosis. Demographic data including age, sex, race, ethnicity, payor status, injury mechanism, and type of sport (if a sport-related injury) were also recorded.

Patients were divided into the following 3 diagnostic categories for the purposes of analysis: intracranial injury, concussion (without intracranial injury), and minor head trauma. Intracranial injury was defined as a skull fracture and/or intracranial hemorrhage. Concussion was defined as previously described.[5] Minor head trauma included superficial hematomas, lacerations, abrasions, or any other head injury without intracranial injury or concussion.

The first period's triage dispositions were: call 911 immediately, ED referral, see PCP within 3 days, and home management. After September 01, 2012, a new disposition, see PCP within 24 hours, was added to these existing options and included in the second period's analysis.

For patients seen in an ED or PCP's office, final diagnosis was abstracted from the recorded diagnosis made by the treating physician. If a patient referred to an ED or PCP's office did not present for medical care as recommended, no diagnosis was recorded and this patient was marked as lost to follow-up. For patients triaged to home management, their diagnosis was recorded as minor head trauma and no head imaging was recorded, unless subsequent encounters for the same injury identified an alternative diagnosis and/or completion of a head computed tomography (CT). If a patient's ED medical encounter occurred outside of the hospital care network (indicated by the triage call or subsequent PCP visits), data were abstracted from scanned records (when available). If a triage nurse's documented final referral recommendation was different than the triage algorithm's recommendation, then, the algorithm's recommended disposition was recorded.



*Referral to the Primary Care Provider (PCP) within 3 days (n=9)

FIGURE 1. Referral recommendation and final diagnosis for sample of patients accessing an after-hours call center for head trauma from September 01, 2011, to December 31, 2011.

Data Analysis

Standard descriptive summaries were used for demographic variables. Categorical variables were compared using χ^2 and Fisher exact tests. Continuous variables were compared using independent *t* tests. Statistical significance was set at a *P* value of less than 0.05. All statistical analysis was performed using Stata (v10.0, StataCorp, College Station, Tex).

RESULTS

A total of 259 and 331 patient encounters meeting criteria were identified from 2011 to 2012, respectively. A random 50% sampling of each year generated 128 charts from 2011 to 164 charts from 2012 for further analysis. One chart was excluded from 2011 and 5 charts were excluded from 2012 for lack of actual head trauma or a duplicate encounter for the same injury, leaving 127 charts from 2011 and 159 charts from 2012. The referral recommendation and final diagnoses for the 2011 and 2012 samples are shown in Figures 1 and 2, respectively. There were 6 cases in 2011 and 8 cases in 2012 where a nurse or physician's final disposition recommendation was different than the triage algorithm's recommendation; for these cases, the algorithm's recommended disposition was used. There were no significant differences in demographics, payor status, sport-related injury, or loss to follow-up between the 2011 and 2012 samples (Table 1). Most injuries were not sport related. Football, followed by soccer, was the most common sport involved in sport-related injuries.

TABLE 1. Demographics of Patients Before (2011) and After (2012) Head Injury Telephone Triage Algorithm Modifications

Demographics	2011 (n =127), % (95% CI)	2012 (n =159), % (95% CI)	*P*
Age, mean (SD)	10.1 (3.6)	10.8 (3.8)	NS
Male sex	59 (51%–68%)	60 (53%–68%)	NS
Race			NS
White	69 (61%–77%)	70 (63%–77%)	
African American	25 (18%–33%)	20 (14%–27%)	
Other	5 (1%–9%)	10 (5%–14%)	
Ethnicity, non-Hispanic	93 (89%–97%)	98 (95%–100%)	NS
Payor			NS
Medicaid	16 (10%–23%)	20 (13%–26%)	
Private	73 (65%–80%)	75 (69%–82%)	
Self-pay	11 (5%–16%)	5 (2%–9%)	
Sport-related injury	35 (27%–43%)	43 (36%–51%)	NS
Most common sports			
Football	34 (22%–49%)	30 (21%–42%)	NS
Soccer	23 (13%–37%)	28 (18%–39%)	NS
Lost to follow-up	10 (6%–17%)	13 (9%–19%)	NS

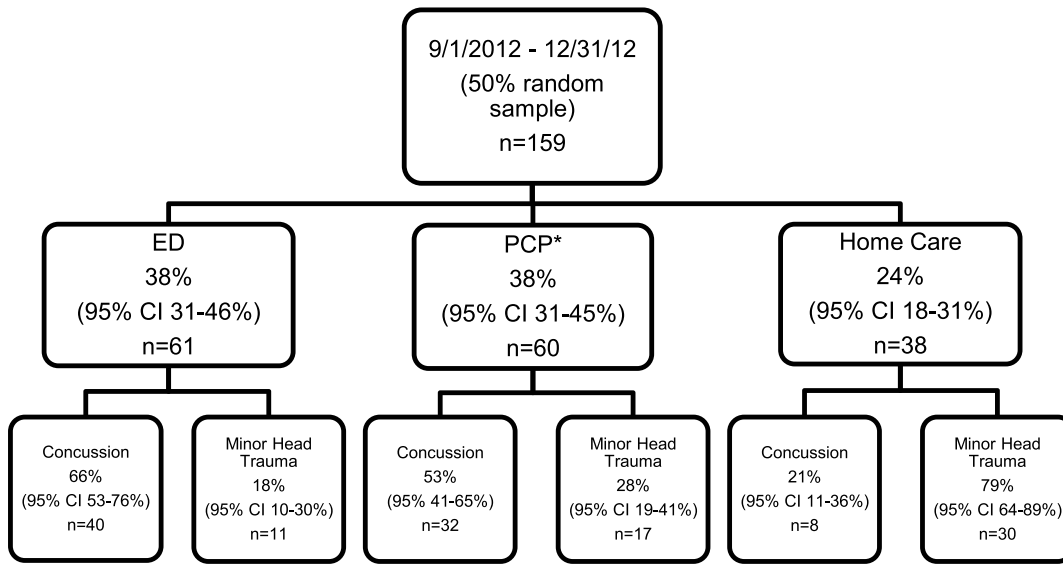
NS indicates not significant.

Referral Disposition

After the head injury triage algorithm modification, the percentage of patients referred to their PCP significantly increased from 7% (95% confidence interval [CI], 4%–13%) to 38% (95% CI, 31%–45%; $P < 0.001$; Table 2). Of note, all patients in 2011 were referred to see their PCP within 3 days (n = 9), whereas patients in 2012 were referred to see their PCP either within 24 hours (n = 59) or within 3 days (n = 1). Also after the modification, the percentage of patients referred to an ED decreased from 2011 to 2012 (43% [95% CI, 35%–52%] to 38% [95% CI, 31%–46%]); however, this decline was not statistically significant (Table 2). There was a significant decrease in patients referred to home care (50% [95% CI, 41%–58%] in 2011 to 24% [95% CI, 18%–31%] in 2012, $P < 0.001$). No patients from either sample were instructed to call 911.

Medical Outcomes

In 2011, there were 114 patients with known final diagnosis and head imaging status. In 2012, there were 145 patients with a



*Referral to the Primary Care Provider (PCP) within 3 days (n=1) and PCP within 24 hours (n=59).

FIGURE 2. Referral recommendation and final diagnosis for sample of patients accessing an after-hours call center for head trauma from September 01, 2012, to December 31, 2012.

TABLE 2. Referral Dispositions for Patients With Head Injury Before and After Telephone Triage Algorithm Modifications

Referral Disposition	2011 (n = 127), % (95% CI)	2012 (n = 159), % (95% CI)	*P*
ED	43 (35%–52%)	38 (31%–46%)	NS
PCP*	7 (4%–13%)	38 (31%–45%)	0.001
Home care	50 (41%–58%)	24 (18%–31%)	0.001

*PCP within 3 days for 2011. PCP within 24 h (n = 59) and PCP within 3 d (n = 1) for 2012.

NS indicates not significant.

known final diagnosis and 138 with known head imaging status. There was a significant increase in concussion diagnoses from 2011 to 2012 (35% [95% CI, 27%–44%] to 58% [95% CI, 50%–66%]; $P < 0.001$; Table 3). The percentage of patients who underwent head CT imaging declined but not significantly (12% [95% CI, 7%–20%] in 2011 to 10% [95% CI, 6%–16%] in 2012). There were neither positive CT findings of acute intracranial pathology in either year nor any patients with a diagnosis of intracranial injury.

DISCUSSION

After an institution-wide concussion initiative including implementation of a revised call center triage algorithm, a significantly increased number of patients with head injury were triaged to PCPs and more concussions were diagnosed. There was a decrease in ED referrals and head CTs, although not statistically significant. Importantly, there were no adverse medical outcomes with this shift to primary evaluation of concussion by a PCP rather than an ED. These prompt PCP visits within 24 hours provide a timely opportunity for evaluation and education on cognitive and physical rest.

After implementation of the revised triage algorithm, a larger number of patients with head injury were initially evaluated by PCPs compared with an ED. Further to this, 40% of all patients ultimately diagnosed with concussion were seen by their PCPs for initial evaluation in 2012 compared with 15% in 2011. This represents a decrease in potentially unnecessary ED visits for these patients with concussions who under the previous algorithm would have been referred to an ED. Before and after the algorithm changes, there were no patients with an intracranial injury inappropriately referred to see their PCP. The lack of adverse medical outcomes and underreferrals with this shift in the referral pattern supports the growing consensus that concussions may be initially evaluated and managed by PCPs.[6]

The percentage of head trauma patients diagnosed with a concussion increased from 2011 to 2012. A recent study within the same health care network before the institution-wide concussion initiative found that a majority of PCPs did not identify more subtle signs of a concussion such as vestibular disturbances or a decline in school performance.[15] The overall increase in concussion diagnoses observed in this study may reflect more sensitive evaluation by providers who benefited from the initiative's concussion-specific continuing medical education and standardized electronic health record templates.

American Academy of Pediatrics guidelines on pediatric head injury do not recommend routine head imaging of all patients with TBI,[16] yet studies report that most children with concussion presenting to an ED undergo head CT.[3,17] Although ED referrals and head CT scans did not significantly decrease after the concussion initiative, future studies should continue to trend these outcomes. Because more suspected concussions are first evaluated by PCPs, ED utilization and CT imaging may decrease further.

Football and soccer were the most common sports in sport-related injuries from both samples. This is expected given their popularity; an estimated 3 million and 1.5 million youth annually participate in soccer and football, respectively.[18] However, most head injuries triaged by the after-hours call center were not sport related, which is consistent with previous studies within the same health care network. Whether sport related or not, treatment for youth with concussions should prioritize focus on "return to learn" and academics before "return to play" and sports participation.[7]

Limitations

This study has limitations that warrant consideration. Both samples' periods were from September to December, and there may be variability in triage patterns and final diagnoses not captured from other months. The relative contributions from each of the initiative's multiple changes are not quantifiable. However, the demonstrated differences in referral patterns and final concussion diagnoses between the 2 periods suggest evolving and updated knowledge of pediatric concussion management. Documentation of patient care was limited to our care network's electronic medical record, and there were some patients with incomplete documentation of outside hospital visits, including head CT results and final diagnoses. Therefore, there exists a potential for undocumented concussions or more severe TBI in those patients lost to follow-up. However, all patients' PCPs were in our care network and all subsequent medical encounters after the initial triage call were reviewed. Thus, it is unlikely that any severe injuries or poor outcomes would remain undocumented by and unknown to a patient's PCP. Some patients lost to follow-up may be explained by a previous telephone triage study that demonstrated greater compliance with home care and ED referrals over intermediary dispositions such as "see PCP within 24 hours," or "see PCP within 3 days."[19] This study did not follow duration of symptoms for patients with a concussion. Thus, it is unknown whether the change in referral patterns affected medical outcomes such as time to resolution of symptoms.

CONCLUSIONS

After implementation of an institution-wide concussion initiative, there were more youths with head injury referred to PCPs and more concussions diagnosed, without an increase in ED referrals. Head injuries triaged by an after-hours call center that are suspected to be concussions may be safely initially evaluated by PCPs.[6] Future studies should continue to trend ED utilization and head CT rates because PCPs become more involved in

TABLE 3. Outcomes of Patients With Head Injury and Known Final Diagnosis

Outcomes	2011, % (95% CI)	2012, % (95% CI)	*P*
Head CT	12 (7%–20%)	10 (6%–16%)	NS
Overall concussion diagnosis	35 (27%–44%)	58 (50%–66%)	<0.001

NS indicates not significant.

initial concussion management. It is important to support clinicians with continuing medical education and contemporary guidelines on best practice concussion management.[15] Concussion resources, such as head trauma telephone triage algorithms, patient information websites, and patient information handouts, should continue to be updated on the basis of emerging new evidence for diagnosis and management.

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