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Impact of newly adopted guidelines for management of children with isolated skull fracture

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ABSTRACT

Purpose: In an effort to standardize practices and reduce unnecessary hospital resource utilization, we implemented guidelines for management of patients with isolated skull fractures (ISF). We sought to examine the impact of these guidelines.
Methods: Patients with nondisplaced/depressed fracture of the skull vault without intracranial hemorrhage were prospectively enrolled from February 2010 to February 2014.
Results: Eighty-eight patients (median age = 10 months) were enrolled. Fall was the most common mechanism of injury (87%). The overall admission rate was 57%, representing an 18% decrease from that reported prior to guideline implementation (2003–2008; $p = 0.001$). Guideline criteria for admission included vomiting, abnormal neurologic exam, concern for abuse, and others. Forty-two percent of patients were admitted outside of the guideline, primarily because of young age (20%). Patients transferred from another hospital (36%) were more likely to be admitted, though the majority (63%) did not meet admission criteria. No ED-discharged patient returned for neurologic symptoms, and none reported significant ongoing symptoms on follow-up phone call.
Conclusions: Implementation of a new guideline for management of ISF resulted in a reduction of admissions without compromising patient safety. Young age remains a common concern for practitioners despite not being a criterion for admission. Interhospital transfer may be unnecessary in many cases.

Head injuries in children remain a common cause of emergency department (ED) visits in the United States [1,2]. Children with normal mental status presenting to an ED with head injury and found to have an isolated skull fracture (ISF) without intracranial injury typically have a good neurologic outcome [3–5], and the need for neurosurgical intervention is very low [3–6]. Yet in a recent retrospective study of 235 children treated at our institution with ISF [3], 75% were admitted for observation and no patient experienced neurologic deterioration during the period of observation—a trend seen across the United States [4]. We hypothesized that admission of these children was unnecessary, and the additional hospital resources, costs, and potential strain to families that are associated with admission may not be justified.

Based on the findings of our review [3], institutional guidelines were developed for the management of children with an ISF in order to help standardize criteria for discharge from the ED versus hospital admission (see Fig. 1). These guidelines were adopted in January of 2012. The aim of this prospective observational study was to determine the impact of this treatment algorithm, specifically on admission rate, and to further evaluate clinical decision-making for these patients.

1. Methods

Patients treated at our pediatric level I trauma center between February 9, 2012 and February 8, 2014 with a skull fracture identified using computed tomography were considered for study inclusion. Patients were screened and enrolled at the time of their treatment by a member of the study team, or identified after discharge using hospital information systems and ICD9 diagnoses codes. In either case, patients with a Glasgow coma score of 15 on arrival were considered eligible for enrollment, unless any of the following exclusion criteria were met: 1) other injuries that influenced admission status, 2) a midface or basilar skull fracture (occipital fractures were included if not reaching the foramen magnum), 3) a significantly displaced or depressed skull fracture, 4) intracranial injury, or 5) the injury occurred more than one day prior to the initial evaluation.

Caregivers of eligible patients were approached for consent to collect data 24–48 hours after ED evaluation regarding any ongoing symptoms (see Table 1). Attempts were made to contact patient caregivers by phone if discharged prior to 24 hours. For patients still hospitalized at

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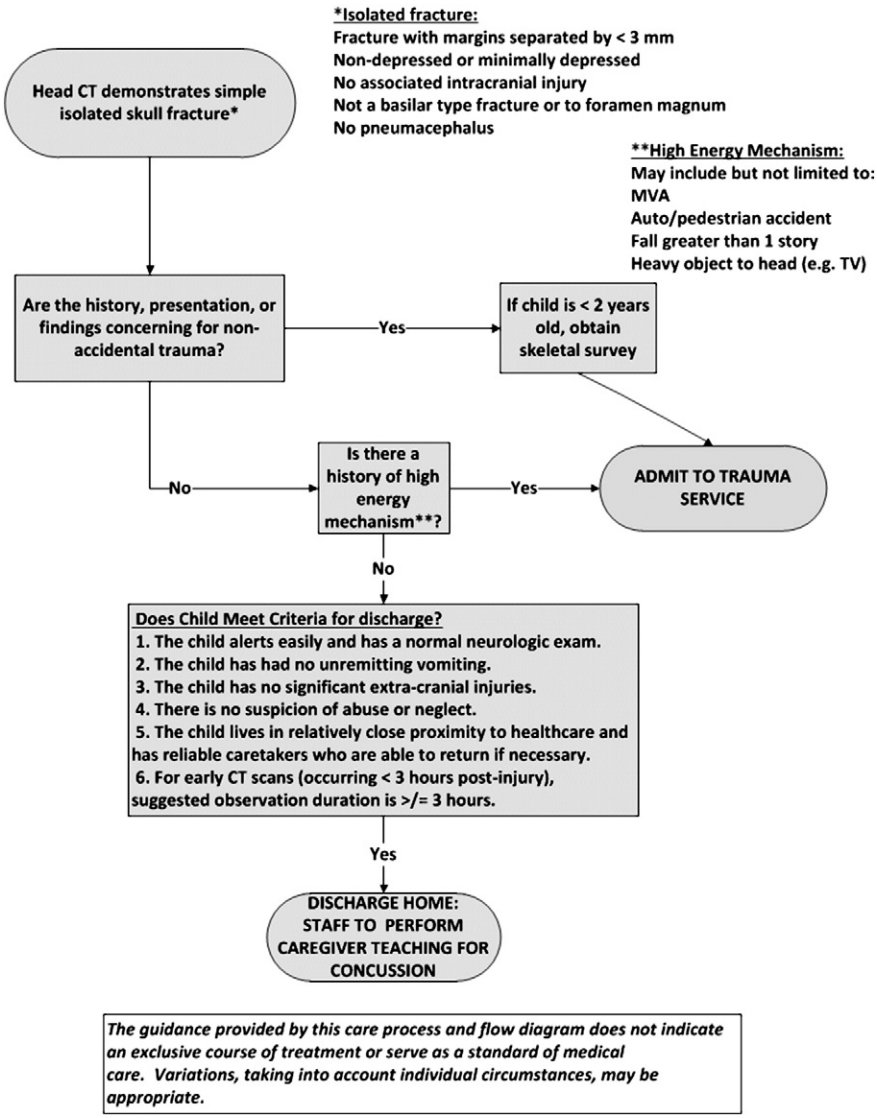

Fig. 1. Management Algorithm for Isolated Skull Fracture. Flow diagram of guidelines for management of isolated skull fracture adopted at our institution in January 2012.

Table 1
Symptoms assessed on follow-up questionnaire.

Major symptoms:
Slurred speech
Confusion
Dripping fluid from nose or ears
Seizure activity
Excessive drowsiness or difficult to wake
Weakness in the arms or legs
Pupils are unequal
Increasing scalp or face swelling
Vomiting more than 3 times since discharge
Minor symptoms:
Headaches
Light or noise sensitivity
Dizziness
Nausea
Blurry or double vision
Problems concentrating
Slow to answer questions
Problems remembering
Irritable or quick tempered
Personality changes
Sleeping difficulties

24–48 hours, the trauma nurse practitioner completed the questionnaire. Three patients declined consent to conduct the follow-up data.

Study data elements included patient age, mechanism of injury, origin of transport to our hospital, radiographic findings, presenting symptoms, ED disposition, hospital services provided, reasons for hospital admission, information about any return visits to medical care, and symptoms reported on the follow-up questionnaire. Descriptive statistics were then performed on these variables. Tests for association were conducted using the Pearson chi-squared method, and differences in distributions using the Wilcoxon rank-sum test. Statistical differences were considered significant if the probability of a type I error was <5% ($p < 0.05$). Study data were collected and managed using Research Electronic Data Capture (REDCap) tools hosted at University of Utah [7]. Approval to conduct this research was obtained from the University of Utah Institutional Review Board.

2. Results

Eighty-eight patients met eligibility criteria for inclusion in the study. This represents 14% of all patients with a skull fracture, and 1.7% of all patients with any head injury treated at our hospital over

Table 2
Characteristics of patients (n = 88).

Age (median, range)	10 months (18 days–16 years)
Mechanism of injury	
Fall[a]	76 (86%)
Bike/scooter/skateboard	5 (5%)
Struck	1 (1%)
Auto vs bike	1 (1%)
Nonaccidental trauma	1 (1%)
Unknown	1 (1%)
High energy mechanism[b]	9 (10%)
Skull fracture location	
Parietal	56 (64%)
Occipital	25 (28%)
Upper temporal	12 (14%)
Frontal	9 (10%)
Multiple bones	13 (15%)
Loss of consciousness	6 (7%)
Unknown	13 (15%)
Symptoms while in the ED	
Vomiting/nausea	17 (19%)
Headache	8 (9%)
Amnesia	3 (3%)
Dizziness	0 (0%)

[a] Mechanism of fall was uncertain in 2 cases owing to possibility of nonaccidental trauma.
[b] Includes falls from at least one story, automobile-vs-bike, skateboarding crash, and struck by falling TV onto head.

the study period. Patient and injury characteristics are summarized in Table 2. The median age was 10 months (range: 18 days to 16 years). Fractures of the parietal bone were the most common type of fracture (56; 64%), and 15% of patients had fracture of more than one skull bone. Falls accounted for 76 (86%) of the injuries, though for 2 of these cases there was some question of whether the trauma was inflicted by another. Nine (10%) patients were injured owing to a high energy mechanism, which was defined as any fall from greater than one story (6), auto-versus-bicyclist (1), skateboarding crash (1), or heavy object (TV) falling on head (1). Six (7%) experienced an initial loss of consciousness, while loss of consciousness was unknown for 13 others (15%). Nausea/vomiting (17; 19%) was the most common symptom during ED evaluation.

During the 2-year study period, 50 (57%) of the study participants were admitted to the hospital. This represents an 18% decrease from the admission rate reported in our previous study [3] conducted prior to guideline implementation (2003–2008; p = 0.001; Fig. 2). Interestingly, the admission rate during the second year of the study was lower than that of the first year (43% vs 68%; p = 0.013). Reasons for admission are listed in Table 3. Persistent vomiting was the most common

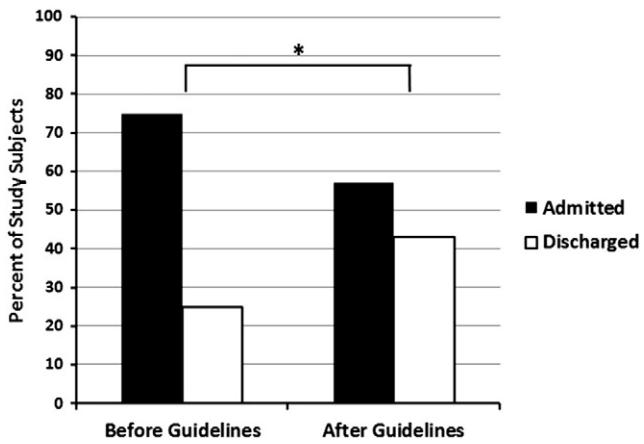

Fig. 2. ED Disposition before vs. after guidelines implementation. Proportion of patients admitted to the hospital and discharged from the emergency department prior to guidelines implementation versus after implementation. * indicates significant association between time period and admission rate (p = 0.001).

Table 3
Reasons given for admitting patient.

	N = 50 (%)
Cases with reasons meeting the management algorithm criteria:	29 (58%)
Unremitting vomiting	13 (26%)
Abnormal neurologic exam	7 (14%)
Concern for abuse	7 (14%)
High energy mechanism	7 (14%)
Patient lives far from healthcare	3 (6%)
Social concerns	1 (2%)
Cases with reasons outside the management algorithm criteria:	21 (42%)
Young age of patient	10 (20%)
Observation/serial neurologic exam	9 (18%)
Concerning symptoms at time of injury (brief altered mental status or impact seizure)	3 (6)
"Fussy"	2 (4%)
Unknown	1 (2%)

reason given for admission (13; 26%). Concerns for abuse, access to healthcare and social environment were noted in 9 (18%) of the admissions (Table 3). Twenty-one (42%) patients were admitted outside of the guidelines (i.e., "Other" was chosen for reason admitted). Of note, young age was a reason given for admission in 10 patients (20% of all admissions). Interestingly, age did not differ between patients admitted to the hospital (median = 0.71 years, IQR = 0.33–2.33) and those discharged from the ED (median = 0.85, IQR = 0.5–2.57; p = 0.156).

Ten admitted patients (20%) underwent skeletal survey. Findings concerning abuse prompted involvement of child protection team in three cases. Neurosurgical evaluation was obtained in 3 (6%) of the patients admitted. No patients underwent more than one head CT at our hospital.

Thirty-two patients (36%) were transferred from another hospital via emergency medical services. Transferred cases were more likely to be admitted than those not transferred (78% (25/32) versus 45% (25/56), respectively; p = 0.002), despite not having a higher rate of admission criteria met compared to those not transferred (38% (12/32) versus 29% (16/56), respectively; p = 0.387).

Thirty-eight patients (43%) had a head CT at an outside facility prior to evaluation at our institution. Twenty-eight (74%) of these 38 cases were overread by a pediatric radiologist at our hospital, and another 2 (5%) cases had a second CT conducted at our hospital (Table 4). For 7 (18%) of the 38 cases with outside imaging, intracranial pathology was questioned (6) or reported (1) by the outside radiologist, and then interpreted as normal upon review by a pediatric radiologist.

The follow-up questionnaire was completed on a subset of patients at 24–48 hours after ED discharge, in order to assess ongoing symptoms (Table 1) or return to medical care. This time window was chosen to compare the rates of ongoing symptoms observed in the admitted group during hospitalization (typically over about 24 hours) to the ED-discharged group. We chose this time period for the follow-up interview to avoid potential recall bias by parents. Also, we wanted to be able to instruct the parents to seek medical care in a timely manner if emergent medical issues were discovered. No symptoms of significance were reported by parents of the ED-discharged patients (0/10; Table 5). Two (9%) of the admitted patients with follow-up obtained did continue to have concussive symptoms. One of them had persistent vomiting, and the other was drowsy. Both were still in the hospital at the time of follow-up, and were later discharged after resolution of symptoms

Table 4
Patients receiving head CT imaging at outside facility (n = 38).

Transferred by emergency medical services	30 (79%)
Referred by private vehicle	8 (21%)
Intracranial pathology questioned or indicated by outside radiologist	6 (18%)
Overread of outside images by our radiologist	28 (74%)
Second CT conducted at our hospital	2 (5%)

Table 5
Comparison of ongoing symptoms and return to medical care.

	ED-discharged patients (n = 38)	Admitted patients (n = 50)
Patients returning to our hospital or affiliated facility within 10 days	0 (0%)	1 (0.5%)
Patients with follow-up questionnaire completed	10 (26%)	23 (46%)
Of those completing follow-up questionnaire, patients with ongoing symptoms of significance	0 of 10	2 of 23
Of those completing follow-up questionnaire, patients with ongoing minor symptoms	2 of 10	10 of 23

without further intervention. Two (20%) of the ED-discharged patients had minor symptoms at the time of follow-up (both had headache and irritability), whereas 10 (44%) of the admitted patients were reported to have ongoing minor symptoms at follow-up (Table 5).

We also reviewed medical records following patient discharge to determine if any patients had returned to our hospital or an affiliated facility within 10 days of being discharged. With the exception of 2 patients that returned to an ED to have staples removed from a laceration (sustained from the initial head injury), no ED-discharged patients (0 of 38) returned for medical care (Table 5). One (0.5%) of the 50 patients initially admitted for observation returned for ongoing symptoms ("fussiness"). The patient was observed in our ED and released without additional imaging or intervention.

3. Discussion

Though controversial, skull fracture is often considered a predictor of intracranial pathology in children presenting to emergency departments with minor head trauma [6,8–12]. However, in children with ISF presenting with normal mental status and no intracranial pathology on initial radiologic evaluation, complications requiring specialized treatment are rare [3–6]. Despite this, the majority of patients with ISF of the skull vault are hospitalized for further observation [3,4]. This prospective study sought to determine the impact of an institutional treatment algorithm on admission rate and to evaluate short term outcomes in these patients.

There are a myriad of reasons why clinicians may feel admission is prudent. These include management of unrelenting vomiting, concerns of inflicted injury or the patient's home environment, proximity to healthcare, or concerns that a high energy mechanism increases the risk of delayed complications. Moreover, somnolence in the very young child may be cause for concern to some since it can be difficult to distinguish from altered mental status. This study attempted to determine the relative frequencies in which these factors play a role in decisions to admit, and whether admissions not meeting our hospital's newly adopted guidelines were still warranted for other reasons. As far as we are aware, this is the first study to describe the impact of a clinical management algorithm specifically focused on children with isolated skull fracture.

Though the implementation of these guidelines appears to have resulted in a statistically significant reduction in admission rate for patients with ISF, the decrease (18%) was modest. It's possible that a greater impact could have been achieved by employing more effective methods of disseminating and reminding clinicians of the newly adopted protocol. We did take steps to help ensure that practitioners remained aware of the new protocol, by presenting the algorithm at regular meetings, and posting the flow chart in strategic locations within the ED. However, these methods are likely less effective than mechanisms that could be potentially employed as institutions implement more advanced electronic charting and computerized clinical decision support systems, which can help alert the clinician to protocols relevant to their patient. We found that of the admitted patients, 58% appeared to have a valid reason for admission. This constitutes 33% of the total study population. Hence, it appears that there exists the potential to further reduce the admission rate at our hospital for these patients, to around 33%. In addition, the finding that the admission rate during the second year was significantly lower than that of the first year suggests the possibility that the newly implemented guidelines took some time to be fully adopted into practice.

Our institutional guidelines follow closely the consensus guidelines issued by an American Academy of Pediatrics expert panel for the evaluation and management of children <2 years old with minor head trauma [13]. The panel recommended that children <2 years with an isolated simple skull fracture and no associated intracranial injury on CT may be considered for discharge if they met criteria similar to our guidelines. It should be noted that our guidelines allow deviation from the algorithm as deemed appropriate by the treating physician.

The results from our follow-up interviews suggest that the algorithm appropriately identified patients who had ongoing symptoms of concern. None of the ED-discharged patients reported such symptoms, but two of the admitted patients had continued concussive symptoms while still in the hospital.

Limitations of this study include the inability to conduct a follow-up questionnaire in the majority of cases, thus, making it difficult to determine fully the rates of ongoing symptoms occurring after ED evaluation in our entire study population. In addition, 16% of patients initially visited an ED not affiliated with our institution. Hence, it is less certain for these cases as to whether they returned to medical care, since we did not have access to hospital records of those facilities. Also, reason for admission was not always recorded by study member at time of admission. In these cases, the reason/s had to be obtained from medical chart.

4. Conclusion

Implementation of a clinical treatment algorithm for the management of children with an ISF and normal neurologic exam on initial evaluation reduced admissions without compromising patient safety. Young age of the patient remains a common concern for practitioners when considering discharge. Our study also suggests that interhospital transfer may be unnecessary in many cases.

Acknowledgments

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