A Matched-Cohort Study of Pediatric Head Injuries: Collecting Data to Inform an Evidence-Based Triage Assessment

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Introduction: Triage nurses are the "first stop" for patients who present to the emergency department for care. The assessment of pediatric head injuries is especially challenging because signs and symptoms of head trauma in children do not correlate well with the risk of closed head injury (CHI).

Methods: A retrospective matched cohort study was conducted to compare 2 groups of patients who presented to a pediatric emergency department for evaluation of a head injury: a CHI-positive cohort and a CHI-negative cohort as identified by computed tomography scan. The purpose of the chart review was to collect specific information from both cohorts which could be used to inform a nurse-driven pediatric head injury assessment tool.

Results: The younger the child, the more likely they were to be asymptomatic. Scalp hematomas in infants <3 months were associated with CHI even if the infants were otherwise asymptomatic. Injuries to the temporal-parietal region were associated with CHI at every age. Frequency of caregiver report of loss of consciousness (LOC) was almost identical in both cohorts. Children in every age category sustained CHIs as the result of minor falls based on standard age-related fall criteria.

Discussion: The infants and children at highest risk for CHI are often the most difficult to assess. The results of this study reinforce the need for a nurse-driven, evidence-based risk scoring system that could be used to aid with early identification of infants and children who are at high risk for CHI.

Key words: Pediatric; Head injury; Head trauma; Triage; Assessment

Triage nurses are often the "first stop" for patients who present to the emergency department for care. It is their responsibility to assess the patient and to assign acuity based on the patient's level of illness or injury. Triage nurses base their decisions on a combination of factors including individual experience, education, and national trauma criteria,[1] as well as triage scales such as the Emergency Severity Index (ESI).[2]

The Problem

Head trauma is one of the most common pediatric injuries and is a significant cause of pediatric death and disability worldwide.[3,4] Traumatic brain injury (TBI) due to head trauma is responsible for more than 70% of fatal pediatric injuries.[4] Children who have had moderate to severe head traumas, as defined by the mechanism of injury and/or the symptoms, typically receive immediate care and emergent imaging. However, most children evaluated in the emergency department for head trauma present with few if any signs of

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TBI,[4] making the severity of the injury difficult to ascertain. Seemingly minor head trauma in a child who appears alert (head trauma resulting in a Glasgow Coma Score [GCS] of 14 or 15) accounts for approximately 50% of TBIs in children.[4]

Children can sustain significant injuries when falling from lower heights than adults.[5,6] Differences such as their proportionally greater cephalic mass and the lower levels of energy necessary to produce intracranial bleeding in children are 2 factors believed to contribute to their increased susceptibility.[6] Due to their portability, as well as the fact that many childhood injuries are unwitnessed and the mechanism severity may be unknown, children with head trauma often present as walk-in patients and are subject to triage before being seen by a provider.

Children with a history of head trauma, especially those who are preverbal, can be challenging to assess because the clinical findings that may indicate closed head injury (CHI) (such as headache, altered mental status, and amnesia) can be subtle or easily overlooked.[4] The children who are at the highest risk for TBI (aged ≤2 years) are also the patients who are the most difficult to assess.[7,8]

Although the incidence of TBI from minor head trauma is low, infants in particular show a higher incidence and often display no outward signs or symptoms of the injury.[7,8] Fewer than 10% of computed tomography (CT) scans in children aged younger than 18 years with minor head trauma show TBIs, and even fewer children will require acute medical or neurosurgical intervention.[9] However, prompt care for those who are at risk can be dependent on the swift, accurate assessment and prioritization by the ED triage nurse. At present, no nurse-driven risk scoring system specific to pediatric head injuries exists.[10]

Review of the Literature

Although several medical studies have sought to create clinical decision rules for seemingly minor pediatric head injuries,[7,9,11–15] most of the rules have been designed to guide the physician's decision as to whether to order a CT scan. Studies addressing pediatric head injuries vary widely in their terminology (intracranial injury, TBI, CHI, clinically important traumatic brain injury [ciTBI], head injury, head trauma) and in what they use as inclusion criteria (head injury on CT, significant head injury on CT, trauma patient versus walk-in patient, hospital admission for concerning symptoms, medical or neurosurgical intervention, death). None are designed to assist the triage nurse in the initial assessment and acuity assignment.[10]

In 2001 Greenes and Schutzman[8] published a risk scoring system for head-injured children aged younger than 2 years. Because so many head-injured children aged younger than 2 years are clinically asymptomatic, this scoring system considered more concrete data such as the age of the child, location of scalp hematoma, and size of scalp hematoma to assign a numerical risk score that would assist physicians in deciding whether to order a head CT scan.

In 2009 the largest multicenter pediatric head injury study in the United States was published by the Pediatric Emergency Care Applied Research Network (PECARN).[9] This prospective study included both a derivation and validation population, collecting data on more than 42,000 patients aged younger than 18 years with a GCS of 14 or 15 (with a seemingly minor head injury). PECARN created two medical decision tools to assess pediatric ciTBI risk: one for children aged younger than 2 years and a separate one for children aged 2 years or older.

In the PECARN study, altered mental status and palpable skull fracture were the highest-risk clinical variables for ciTBI in children aged younger than 2 years (4.4% risk of ciTBI).[9] The presence of a non-frontal scalp hematoma, history of loss of consciousness (LOC) greater than or equal to 5 seconds, severe mechanism of injury, and/or "not acting normally per parents" were found to be "moderate-risk" clinical variables. If none of the previously mentioned variables were present, the risk of ciTBI was extremely low. In children aged 2 years or older, altered mental status and signs of basilar skull fracture carried the highest risk (4.3% risk) of ciTBI, whereas other, moderate-risk clinical variables were found to be history of LOC, history of (any) vomiting, severe headache, or severe mechanism of injury. If none of these variables were present, the risk of ciTBI was extremely low.

Because of the proximity of the temporal-parietal region to the middle meningeal artery, an injury to this region is more likely to result in intracranial bleeding than an injury to the frontal region. This higher risk is reflected in the decision rules of both Greenes and Schutzman[8] and PECARN[9] mentioned earlier. Ruptured middle meningeal arteries are associated with approximately 80% of epidural hematomas.[16] Intracranial hematomas (typically subdural and epidural) are well known for producing delayed and/or deteriorating symptoms, sometimes preceded by a "lucid interval" in which the person is awake and able to communicate. One study, by Arbogast et al,[17] examined patterns of initial neurologic presentation in infants and toddlers with fatal head injuries. The data, based on a study population of 314 children aged younger than 48 months, suggested that the presence of a lucid interval was age and mechanism dependent; it was unclear whether these differences were due to inaccurate reporting (because of the challenges of assessing GCS in nonverbal infants and children) or due to differences in how the infant and toddler brain responds to traumatic injury.