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To scan or not to scan: overutilization of computed tomography for minor head injury at a pediatric trauma center



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ABSTRACT

Background: Degree of compliance with Pediatric Emergency Care Applied Research Network (PECARN) recommendations for radiographic evaluation following minor head injury in children is not well understood. The aim of this study was to assess PECARN compliance at a pediatric trauma center. The secondary aim was to determine whether children with indeterminate history of loss of consciousness (LOC) are at greater risk for clinically important traumatic brain injury (ciTBI) than those with no LOC.

Materials and methods: We identified children aged 0-17 y who presented <24 h after minor head injury with Glasgow Coma Scale ≥ 14 in our institutional trauma registry. Predictor variables for ciTBI (TBI resulting in admission ≥ 2 nights, intubation ≥ 24 h, neurosurgery, or death) were reviewed. Simple and multivariate logistic regressions were performed to estimate the independent effects of demographic and clinical characteristics on the outcome of ciTBI.

Results: We included 739 children. Incidence of ciTBI was 5.4%. Only 5.6% did not undergo computed tomography (CT). PECARN compliance was 92.6% overall, but only 23.0% in those for whom CT was not indicated. Among those for whom either CT or observation was acceptable, 93.7% underwent CT. LOC history was indeterminate in 8.5%. On multivariate analysis, indeterminate LOC was not a risk factor for ciTBI. Vomiting and presence of occipital/parietal/temporal scalp hematoma were independent risk factors for ciTBI.

Conclusions: CT is overutilized in pediatric trauma patients presenting to our institution after minor head injury when compared to PECARN criteria. Indeterminate LOC history was not a risk factor for ciTBI. Education of parents and clinicians regarding the risk to benefit ratio of CT in trauma patients with minor head injury is needed.

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Background

Traumatic brain injury (TBI) accounts for over half a million pediatric emergency department (ED) visits annually in the United States.¹ Many of these visits include computed tomography (CT) scan to evaluate for TBI.²⁻⁴ While CT is effective in diagnosing TBI, it increases a child's risk of developing malignancy.^{5,6} It is estimated that between two and ten in every 10,000 CT scans of the head will result in lethal malignancy, with the risk increasing as age at the time of CT decreases.⁷ Moreover, CT imaging is costly.^{8,9} To distinguish between children who may benefit from CT and those who likely would not, the Pediatric Emergency Care Applied Research Network (PECARN) derived and validated an algorithm that identifies children at risk for clinically important TBI (ciTBI) after a minor head injury.¹⁰ While the validity of the PECARN algorithm has been established in subsequent studies, with one recent multiinstitutional prospective study demonstrating a sensitivity of 100% in children aged less than 2 y and 99% in children aged 2 y and older, the extent to which PECARN recommendations are followed at pediatric hospitals is not well understood.^{11,12} The primary aim of this study was to determine our institution's compliance with these recommendations. Additionally, we examined patient outcomes associated with a particular component of the PECARN algorithm, history of loss of consciousness (LOC), to determine whether children for whom history of LOC is indeterminate are at greater risk for ciTBI than those who report no LOC.

Materials and methods

After institutional review board approval, we performed a retrospective review of the institutional trauma registry at a freestanding children's hospital of children aged 0-17 y presenting within 24 h of minor head injury with score of 14 or 15 on the Glasgow Coma Scale (GCS) between January 1, 2010 and April 30, 2017. Waiver of consent was granted by the institutional review board for this retrospective study. Those who underwent CT before arrival, those with penetrating injuries or ventriculoperitoneal shunts, those for whom nonaccidental trauma was suspected, and those with insufficient documentation in the medical record were excluded. Age-specific predictor variables for ciTBI, defined as imaging-confirmed TBI resulting in hospital admission for two or more nights, intubation for greater than 24 h, neurosurgical intervention, or death, were collected. Inclusion and exclusion criteria, predictor variables for ciTBI, and definition of ciTBI were chosen with reference to those published in the landmark PECARN study.¹⁰

To summarize briefly, the algorithm derived in the PECARN study channels children into one of three management groups based on age and presenting signs and symptoms (Fig. 1). In the first of these groups, CT is recommended; in the second, either CT or a period of observation may be appropriate, with the decision between the two being based on additional specified factors; in the final group, CT is not recommended. For the purposes of our study, cases were considered compliant if the decision to perform or forego CT was

consistent with PECARN recommendations based on the patient's clinical presentation as documented in the trauma registry and medical record. With respect to our definition of LOC status, we considered children with a documented report of LOC (as conveyed by the patient, caregiver, bystander, or emergency medical services personnel) to have a positive history of LOC. Conversely, we considered patients with a documented testimony of no LOC to have a negative history of LOC. Finally, we classified those cases in which the event was unwitnessed and the patient could not reliably give an account of LOC status immediately following the event as "indeterminate history of LOC".

Descriptive statistics were calculated for demographics, injury characteristics, compliance with PECARN recommendations, and clinical outcomes. Binary dependent variables with categorical independent variables were analyzed using chi-square or Fisher's exact test. Simple logistic regression was performed to determine the effects of age, sex, history of LOC, GCS, altered mental status, mechanism of injury severity, and various clinical signs and symptoms on the primary outcome of ciTBI. Variables were determined based upon a review of the literature, with specific attention to variables included in the PECARN prediction rules for ciTBI.^{10,18,19} Variables found on simple logistic regression to have an association with ciTBI characterized by P value < 0.10 were included in the multivariate model. An alpha level of 0.05 was used for all additional statistical tests. Statistical analysis was performed using Stata/IC 15.1 (StataCorp, College Station, TX).

Results

Of 1852 patients screened in the registry, 739 (39.9%) met inclusion criteria, 1050 (56.7%) were excluded because they had received a CT of the head at an outside facility before transfer, and the remaining 61 (3.3%) were excluded due to ventriculoperitoneal shunt, penetrating trauma, suspicion for nonaccidental trauma, or insufficient documentation. The majority of those included (66.2%) were male (Table 1). Median age was 7.8 y (IQR 1.9-13.8). Approximately three quarters (74.8%) were aged 2 y or older. Overall incidence of TBI observed on imaging was 20.0%. In contrast, incidence of ciTBI was only 5.4%. Only 41 children (5.6%) did not undergo CT imaging. Overall institutional compliance with PECARN guidelines was 92.6% (Fig. 2). However, among those for whom CT was not indicated, compliance was markedly lower (23.0%). Additionally, compliance was decreased among children aged less than 2 y as compared with those aged 2 y and older (86.6% versus 94.6%, $P < 0.001$). Among those for whom either CT or observation was acceptable based on initial signs and symptoms, the overwhelming majority (94%) underwent CT evaluation (Fig. 3).

With respect to the secondary aim of the study, which was to determine whether children with indeterminate history of LOC are at greater risk for ciTBI than those who report a negative history of LOC, we found that the majority of children (56.4%) reported no LOC, 35.1% reported LOC, and for the remaining 8.5% LOC history was indeterminate. On multivariate analysis, indeterminate LOC was not a risk factor for ciTBI

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