

# Association of Traumatic Brain Injuries With Vomiting in Children With Blunt Head Trauma

Peter S. Dayan, MD, MSc\*; James F. Holmes, MD, MPH; Shireen Atabaki, MD, MPH; John Hoyle Jr, MD; Michael G. Tunik, MD; Richard Lichenstein, MD; Elizabeth Alpern, MD, MSCE; Michelle Miskin, MS; Nathan Kuppermann, MD, MPH; for the Traumatic Brain Injury Study Group of the Pediatric Emergency Care Applied Research Network (PECARN)<sup>†</sup>

\*Corresponding Author. E-mail: [psd6@columbia.edu](mailto:psd6@columbia.edu).

**Study objective:** We aimed to determine the prevalence of traumatic brain injuries in children who vomit after minor blunt head trauma, particularly when the vomiting occurs without other findings suggestive of traumatic brain injury (ie, isolated vomiting). We also aimed to determine the relationship between the timing and degree of vomiting and traumatic brain injury prevalence.

**Methods:** This was a secondary analysis of children younger than 18 years with minor blunt head trauma. Clinicians assessed for history and characteristics of vomiting at the initial evaluation. We assessed for the prevalence of clinically important traumatic brain injury and traumatic brain injury on computed tomography (CT).

**Results:** Of 42,112 children enrolled, 5,557 (13.2%) had a history of vomiting, of whom 815 of 5,392 (15.1%) with complete data had isolated vomiting. Clinically important traumatic brain injury occurred in 2 of 815 patients (0.2%; 95% confidence interval [CI] 0% to 0.9%) with isolated vomiting compared with 114 of 4,577 (2.5%; 95% CI 2.1% to 3.0%) with nonisolated vomiting (difference -2.3%, 95% CI -2.8% to -1.5%). Of patients with isolated vomiting for whom CT was performed, traumatic brain injury on CT occurred in 5 of 298 (1.7%; 95% CI 0.5% to 3.9%) compared with 211 of 3,284 (6.4%; 95% CI 5.6% to 7.3%) with nonisolated vomiting (difference -4.7%; 95% CI -6.0% to -2.4%). We found no significant independent associations between prevalence of clinically important traumatic brain injury and traumatic brain injury on CT with either the timing of onset or time since the last episode of vomiting.

**Conclusion:** Traumatic brain injury on CT is uncommon and clinically important traumatic brain injury is very uncommon in children with minor blunt head trauma when vomiting is their only sign or symptom. Observation in the emergency department before determining the need for CT appears appropriate for many of these children. [Ann Emerg Med. 2014;63:657-665.]

Please see page 658 for the Editor's Capsule Summary of this article.

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## INTRODUCTION

### Background and Importance

Blunt head trauma in children results in more than 450,000 emergency department (ED) visits annually in the United States.<sup>1</sup> Most blunt head trauma is minor and is associated with a very low prevalence of clinically important traumatic brain injuries.<sup>2,3</sup> Recently, there has been substantial attention in the medical literature and lay press about the use of computed tomography (CT) scanning for children with minor blunt head trauma. Recent research has in great part focused on the risks of radiation-induced malignancy and therefore the need to use CT judiciously.<sup>4,5</sup>

<sup>†</sup>All participants are listed in the Appendix.

Children with minor blunt head trauma frequently present to the ED with a history of vomiting.<sup>2,3</sup> Although vomiting is common in children with traumatic brain injuries (both clinically important traumatic brain injuries and traumatic brain injuries on CT), it also occurs in those with head trauma without traumatic brain injury, and therefore controversy exists about whether vomiting by itself discriminates between those who do and do not have traumatic brain injuries. In a previous meta-analysis, the presence of vomiting in children after head trauma, regardless of other symptoms or signs of traumatic brain injury, did not increase the overall prevalence of intracranial hemorrhage on CT, although it did increase the prevalence of neurosurgery.<sup>6</sup> Pooled estimates and previous studies, however, have not provided the prevalence of traumatic brain injury when vomiting is the only sign or symptom.

### Editor's Capsule Summary

#### *What is already known on this topic*

Prediction rules for evaluation of pediatric blunt head trauma patients often include vomiting as a risk factor, but the meaning of vomiting in the absence of other signs and symptoms is unknown.

#### *What question this study addressed*

This secondary analysis of a multicenter study of 42,112 children compared the prevalence of clinically important traumatic brain injury after minor blunt head trauma in children with isolated vomiting with that of children with nonisolated vomiting.

#### *What this study adds to our knowledge*

Five thousand three hundred ninety-two children had vomiting, and 0.2% of the 815 with isolated vomiting had clinically important traumatic brain injury versus 2.5% of the 4,577 with nonisolated vomiting.

#### *How this is relevant to clinical practice*

Clinicians may consider observation in place of imaging studies in children with vomiting as the sole risk factor after minor blunt head trauma.

Vomiting has variably been included in prediction rules of traumatic brain injury in children with blunt head trauma.<sup>7</sup> In several prediction models of traumatic brain injury that do not include vomiting, children misclassified as not having traumatic brain injury (clinically important traumatic brain injury or traumatic brain injury on CT) frequently had a history of vomiting.<sup>7</sup> Our Pediatric Emergency Care Applied Research Network (PECARN) group derived and validated prediction rules separately for children younger than 2 years and those aged 2 to 18 years to identify children at very low risk of clinically important traumatic brain injury for whom CT scans can typically be obviated. For patients aged 2 to 18 years, those with a history of vomiting are classified as not being at very low risk of clinically important traumatic brain injury.<sup>2</sup> A history of vomiting, however, does not necessarily indicate that a patient is at high risk of clinically important traumatic brain injury, particularly if the history of vomiting is present in the absence of other signs or symptoms of traumatic brain injury (ie, isolated vomiting).

### Goals of This Investigation

To more fully understand the importance of a history of vomiting, we aimed to determine the prevalence and types of clinically important traumatic brain injuries and traumatic brain injuries on CT in children who vomit after minor blunt head

trauma, particularly those who have isolated vomiting. Additionally, we aimed to assess the relationship between the timing and degree of vomiting with the prevalence of clinically important traumatic brain injury and traumatic brain injury on CT. Finally, we sought to provide the prevalence of clinically important traumatic brain injury and traumatic brain injury on CT when patients have vomiting and 1 other important sign or symptom of traumatic brain injury, as is often found in clinical practice.

## MATERIALS AND METHODS

### Study Design and Setting

We performed a planned secondary analysis of data from a large prospective observational cohort study conducted at 25 centers in the PECARN between June 2004 and September 2006. The study was approved by each site's institutional review board. Full details of the study have been published previously.<sup>2</sup> Below, we present details specific to the present analysis.

### Selection of Participants

In the main cohort study, we enrolled children younger than 18 years with Glasgow Coma Scale scores of 14 to 15 after nontrivial blunt head trauma who presented to the ED within 24 hours of the injury. We excluded patients with trivial trauma, defined by that resulting from ground-level falls or running into stationary objects, with no evidence of traumatic brain injury other than scalp abrasions or lacerations. We excluded patients with penetrating head trauma, preexisting neurologic disease impeding clinical assessment, or syncope or seizure preceding the head trauma, as well as patients transferred to the ED with neuroimaging already obtained. For this secondary analysis, we also excluded patients with bleeding disorders or ventricular shunts. We did not exclude patients with trauma to other body regions in association with head trauma or those who were potential victims of abuse.

### Methods of Measurement

Clinicians completed a standardized history and physical examination before cranial CT (if obtained) and documented the findings on a case report form. They evaluated for the presence or absence of a history of vomiting that occurred at any time after the traumatic event, up to the time of their ED evaluation (ie, included vomiting in the ED but only up to the time of evaluation). If vomiting was present, clinicians documented the number of vomiting episodes (categorized as 1, 2, >2, or unknown), the timing of onset (before head injury, within 1 hour of injury, 1 to 4 hours after the injury, >4 hours after the injury, or unknown), and the time since the last episode (<1 hour before ED evaluation, 1 to 4 hours before ED evaluation, >4 hours before ED evaluation, or unknown). We defined multiple retching/vomiting within a 1-minute period as 1 episode of vomiting.

Two clinicians independently evaluated a convenience sample of 4% of patients to assess interobserver agreement of findings from patient history and physical examination. The presence of a history of vomiting ( $\kappa$  score of 0.91; lower 95% confidence interval [CI] 0.89) had excellent interobserver agreement.<sup>8</sup>

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