**Feedback from an Emergency Department physician:**

1st box - curious as to why 3 or more of the listed symptoms and do not think that any three warrant admission.  For example, if a patient had severe mech of injury, scalp hematoma, and hx of LOC...that wouldn't warrant admission if they looked well in the ED with or without neuroimaging.  In clinical practice, there are a few things that require admission as follows:

1. Concern for progressing intracranial hemorrhage

2. Failure to tolerate PO

3. Failure to ambulate steadily

  2nd box (are symptoms severe)  is slightly redundant because in the previous box we have listed severe HA.  Additionally, severe would not apply to several of the items listed in box 1.

 3rd box (chronic illnesses)  Not sure why it matters if the child has, for example, asthma in relation to an admission for presumed mTBI.  This would not sway me in any way to admit.  The chronic illness I would care about would be a bleeding disorder or something like osteogenesis imperfect in which a small head injury is likely to cause a skull fracture, or in which being slightly off balance and falling could have disastrous consequences.

 4th box (was GCS captured) if answer is no, should direct clinician to assess for it, not move directly to whether or not a CT was obtained.

Was CT abnormal - this decision point is unclear.  Many institutions do not admit isolated skull fractures but this tree is recommending it. I am a co-author on several recent publications in JAMA peds and Pediatrics that go against this recommendation.  Additionally the branch point regarding admitting for cerebral contusions would be an abnormal finding, not a "no".

**Physical Medicine and Rehabilitation Physician who works in a Pediatric level 1 trauma Center**

Below are a couple of thoughts.

1. Our ED tends to use the Kuppermann decision rule to assess risk of “significant” intracranial injury. Below are some abstracts from the series of articles published on the topic. For the most part, mild brain injuries don’t’ require admission. One thing missing from this is probably social factors and/or concern for abuse. That is, if there are extenuating social factors or concern for abuse, patients are more likely to be admitted even if the injury is mild.
2. There is probably also an observation step where a patient is observed for some period of time in the ED and if doing well will be discharged home.
3. In general, almost anyone with imaging findings is probably admitted and observed for at least 24-48 hours to make sure they don’t worsen. This is usually done in consultation with neurosurgery.

Here are some articles on this topic-

Select item 289524491.

[Lancet.](https://www.ncbi.nlm.nih.gov/pubmed) 2017 Sep 23;390(10101):1487-1488. doi: 10.1016/S0140-6736(17)32153-0.

[**Head injury decision rules in children.**](https://www.ncbi.nlm.nih.gov/pubmed/28952449)

[Kuppermann N](https://www.ncbi.nlm.nih.gov/pubmed/?term=Kuppermann%20N%5BAuthor%5D&cauthor=true&cauthor_uid=28952449)1, [Holmes JF](https://www.ncbi.nlm.nih.gov/pubmed/?term=Holmes%20JF%5BAuthor%5D&cauthor=true&cauthor_uid=28952449)2, [Dayan PS](https://www.ncbi.nlm.nih.gov/pubmed/?term=Dayan%20PS%5BAuthor%5D&cauthor=true&cauthor_uid=28952449)3.

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[10.1016/S0140-6736(17)32153-0](https://doi.org/10.1016/S0140-6736(17)32153-0)

**Publication type**

* [Letter](https://www.ncbi.nlm.nih.gov/pubmed)

Select item 283417992.

[Pediatrics.](https://www.ncbi.nlm.nih.gov/pubmed) 2017 Apr;139(4). pii: e20162709. doi: 10.1542/peds.2016-2709.

[**Use of Traumatic Brain Injury Prediction Rules With Clinical Decision Support.**](https://www.ncbi.nlm.nih.gov/pubmed/28341799)

[Dayan PS](https://www.ncbi.nlm.nih.gov/pubmed/?term=Dayan%20PS%5BAuthor%5D&cauthor=true&cauthor_uid=28341799)1, [Ballard DW](https://www.ncbi.nlm.nih.gov/pubmed/?term=Ballard%20DW%5BAuthor%5D&cauthor=true&cauthor_uid=28341799)2,3, [Tham E](https://www.ncbi.nlm.nih.gov/pubmed/?term=Tham%20E%5BAuthor%5D&cauthor=true&cauthor_uid=28341799)4, [Hoffman JM](https://www.ncbi.nlm.nih.gov/pubmed/?term=Hoffman%20JM%5BAuthor%5D&cauthor=true&cauthor_uid=28341799)5, [Swietlik M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Swietlik%20M%5BAuthor%5D&cauthor=true&cauthor_uid=28341799)6, [Deakyne SJ](https://www.ncbi.nlm.nih.gov/pubmed/?term=Deakyne%20SJ%5BAuthor%5D&cauthor=true&cauthor_uid=28341799)6, [Alessandrini EA](https://www.ncbi.nlm.nih.gov/pubmed/?term=Alessandrini%20EA%5BAuthor%5D&cauthor=true&cauthor_uid=28341799)7, [Tzimenatos L](https://www.ncbi.nlm.nih.gov/pubmed/?term=Tzimenatos%20L%5BAuthor%5D&cauthor=true&cauthor_uid=28341799)8,9, [Bajaj L](https://www.ncbi.nlm.nih.gov/pubmed/?term=Bajaj%20L%5BAuthor%5D&cauthor=true&cauthor_uid=28341799)4, [Vinson DR](https://www.ncbi.nlm.nih.gov/pubmed/?term=Vinson%20DR%5BAuthor%5D&cauthor=true&cauthor_uid=28341799)3,10, [Mark DG](https://www.ncbi.nlm.nih.gov/pubmed/?term=Mark%20DG%5BAuthor%5D&cauthor=true&cauthor_uid=28341799)11, [Offerman SR](https://www.ncbi.nlm.nih.gov/pubmed/?term=Offerman%20SR%5BAuthor%5D&cauthor=true&cauthor_uid=28341799)12, [Chettipally UK](https://www.ncbi.nlm.nih.gov/pubmed/?term=Chettipally%20UK%5BAuthor%5D&cauthor=true&cauthor_uid=28341799)13, [Paterno MD](https://www.ncbi.nlm.nih.gov/pubmed/?term=Paterno%20MD%5BAuthor%5D&cauthor=true&cauthor_uid=28341799)14, [Schaeffer MH](https://www.ncbi.nlm.nih.gov/pubmed/?term=Schaeffer%20MH%5BAuthor%5D&cauthor=true&cauthor_uid=28341799)15, [Wang J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Wang%20J%5BAuthor%5D&cauthor=true&cauthor_uid=28341799)16, [Casper TC](https://www.ncbi.nlm.nih.gov/pubmed/?term=Casper%20TC%5BAuthor%5D&cauthor=true&cauthor_uid=28341799)16, [Goldberg HS](https://www.ncbi.nlm.nih.gov/pubmed/?term=Goldberg%20HS%5BAuthor%5D&cauthor=true&cauthor_uid=28341799)14,15, [Grundmeier RW](https://www.ncbi.nlm.nih.gov/pubmed/?term=Grundmeier%20RW%5BAuthor%5D&cauthor=true&cauthor_uid=28341799)17, [Kuppermann N](https://www.ncbi.nlm.nih.gov/pubmed/?term=Kuppermann%20N%5BAuthor%5D&cauthor=true&cauthor_uid=28341799)8,9; [Pediatric Emergency Care Applied Research Network (PECARN)](https://www.ncbi.nlm.nih.gov/pubmed/?term=Pediatric%20Emergency%20Care%20Applied%20Research%20Network%20(PECARN)%5BCorporate%20Author%5D); [Clinical Research on Emergency Services and Treatment (CREST) Network](https://www.ncbi.nlm.nih.gov/pubmed/?term=Clinical%20Research%20on%20Emergency%20Services%20and%20Treatment%20(CREST)%20Network%5BCorporate%20Author%5D); [and Partners Healthcare; Traumatic Brain Injury-Knowledge Translation Study Group](https://www.ncbi.nlm.nih.gov/pubmed/?term=and%20Partners%20Healthcare%3B%20Traumatic%20Brain%20Injury-Knowledge%20Translation%20Study%20Group%5BCorporate%20Author%5D).

**Abstract**

**OBJECTIVES:**

We determined whether implementing the Pediatric Emergency Care Applied Research Network (PECARN) traumatic brain injury (TBI) prediction rules and providing risks of clinically important TBIs (ciTBIs) with computerized clinical decision support (CDS) reduces computed tomography (CT) use for children with minor head trauma.

**METHODS:**

Nonrandomized trial with concurrent controls at 5 pediatric emergency departments (PEDs) and 8 general EDs (GEDs) between November 2011 and June 2014. Patients were <18 years old with minor blunt head trauma. Intervention sites received CDS with CT recommendations and risks of ciTBI, both for patients at very low risk of ciTBI (no Pediatric Emergency Care Applied Research Network rule factors) and those not at very low risk. The primary outcome was the rate of CT, analyzed by site, controlling for time trend.

**RESULTS:**

We analyzed 16 635 intervention and 2394 control patients. Adjusted for time trends, CT rates decreased significantly (*P* < .05) but modestly (2.3%-3.7%) at 2 of 4 intervention PEDs for children at very low risk. The other 2 PEDs had small (0.8%-1.5%) nonsignificant decreases. CT rates did not decrease consistently at the intervention GEDs, with low baseline CT rates (2.1%-4.0%) in those at very low risk. The control PED had little change in CT use in similar children (from 1.6% to 2.9%); the control GED showed a decrease in the CT rate (from 7.1% to 2.6%). For all children with minor head trauma, intervention sites had small decreases in CT rates (1.7%-6.2%).

**CONCLUSIONS:**

The implementation of TBI prediction rules and provision of risks of ciTBIs by using CDS was associated with modest, safe, but variable decreases in CT use. However, some secular trends were also noted.

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Select item 268257553.

[Acad Emerg Med.](https://www.ncbi.nlm.nih.gov/pubmed) 2016 May;23(5):566-75. doi: 10.1111/acem.12923. Epub 2016 Apr 20.

[**Comparison of Prediction Rules and Clinician Suspicion for Identifying Children With Clinically Important Brain Injuries After Blunt Head Trauma.**](https://www.ncbi.nlm.nih.gov/pubmed/26825755)

[Atabaki SM](https://www.ncbi.nlm.nih.gov/pubmed/?term=Atabaki%20SM%5BAuthor%5D&cauthor=true&cauthor_uid=26825755)1, [Hoyle JD Jr](https://www.ncbi.nlm.nih.gov/pubmed/?term=Hoyle%20JD%20Jr%5BAuthor%5D&cauthor=true&cauthor_uid=26825755)2,3, [Schunk JE](https://www.ncbi.nlm.nih.gov/pubmed/?term=Schunk%20JE%5BAuthor%5D&cauthor=true&cauthor_uid=26825755)4, [Monroe DJ](https://www.ncbi.nlm.nih.gov/pubmed/?term=Monroe%20DJ%5BAuthor%5D&cauthor=true&cauthor_uid=26825755)5, [Alpern ER](https://www.ncbi.nlm.nih.gov/pubmed/?term=Alpern%20ER%5BAuthor%5D&cauthor=true&cauthor_uid=26825755)6,7, [Quayle KS](https://www.ncbi.nlm.nih.gov/pubmed/?term=Quayle%20KS%5BAuthor%5D&cauthor=true&cauthor_uid=26825755)8, [Glass TF](https://www.ncbi.nlm.nih.gov/pubmed/?term=Glass%20TF%5BAuthor%5D&cauthor=true&cauthor_uid=26825755)9,10, [Badawy MK](https://www.ncbi.nlm.nih.gov/pubmed/?term=Badawy%20MK%5BAuthor%5D&cauthor=true&cauthor_uid=26825755)11,12, [Miskin M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Miskin%20M%5BAuthor%5D&cauthor=true&cauthor_uid=26825755)4, [Schalick WO](https://www.ncbi.nlm.nih.gov/pubmed/?term=Schalick%20WO%5BAuthor%5D&cauthor=true&cauthor_uid=26825755)13, [Dayan PS](https://www.ncbi.nlm.nih.gov/pubmed/?term=Dayan%20PS%5BAuthor%5D&cauthor=true&cauthor_uid=26825755)14, [Holmes JF](https://www.ncbi.nlm.nih.gov/pubmed/?term=Holmes%20JF%5BAuthor%5D&cauthor=true&cauthor_uid=26825755)15, [Kuppermann N](https://www.ncbi.nlm.nih.gov/pubmed/?term=Kuppermann%20N%5BAuthor%5D&cauthor=true&cauthor_uid=26825755)15,16.

**Abstract**

**OBJECTIVE:**

Children with minor head trauma frequently present to emergency departments (EDs). Identifying those with traumatic brain injuries (TBIs) can be difficult, and it is unknown whether clinical prediction rules outperform clinician suspicion. Our primary objective was to compare the test characteristics of the Pediatric Emergency Care Applied Research Network (PECARN) TBI prediction rules to clinician suspicion for identifying children with clinically important TBIs (ciTBIs) after minor blunt head trauma. Our secondary objective was to determine the reasons for obtaining computed tomography (CT) scans when clinical suspicion of ciTBI was low.

**METHODS:**

This was a planned secondary analysis of a previously conducted observational cohort study conducted in PECARN to derive and validate clinical prediction rules for ciTBI among children with minor blunt head trauma in 25 PECARN EDs. Clinicians recorded their suspicion of ciTBI before CT as <1, 1-5, 6-10, 11-50, or >50%. We defined ciTBI as 1) death from TBI, 2) neurosurgery, 3) intubation for more than 24 hours for TBI, or 4) hospital admission of 2 nights or more associated with TBI on CT. To avoid overfitting of the prediction rules, we performed comparisons of the prediction rules and clinician suspicion on the validation group only. On the validation group, we compared the test accuracies of clinician suspicion > 1% versus having at least one predictor in the PECARN TBI age-specific prediction rules for identifying children with ciTBIs (one rule for children <2 years [preverbal], the other rule for children >2 years [verbal]).

**RESULTS:**

In the parent study, we enrolled 8,627 children to validate the prediction rules, after enrolling 33,785 children to derive the prediction rules. In the validation group, clinician suspicion of ciTBI was recorded in 8,496/8,627 (98.5%) patients, and 87 (1.0%) had ciTBIs. CT scans were obtained in 2,857 (33.6%) patients in the validation group for whom clinician suspicion of ciTBI was recorded, including 2,099/7,688 (27.3%) of those with clinician suspicion of ciTBI of <1% and 758/808 (93.8%) of those with clinician suspicion >1%. The PECARN prediction rules were significantly more sensitive than clinician suspicion >1% of ciTBI for preverbal (100% [95% confidence interval {CI} = 86.3% to 100%] vs. 60.0% [95% CI = 38.7% to 78.9%]) and verbal children (96.8% [95% CI = 88.8% to 99.6%] vs. 64.5% [95% CI = 51.3% to 76.3%]). Prediction rule specificity, however, was lower than clinician suspicion >1% for preverbal children (53.6% [95% CI = 51.5% to 55.7%] vs. 92.4% [95% CI = 91.2% to 93.5%]) and verbal children (58.2% [95% CI = 56.9% to 59.4%] vs. 90.6% [95% CI = 89.8% to 91.3%]). Of the 7,688 patients in the validation group with clinician suspicion recorded as <1%, CTs were nevertheless obtained in 2,099 (27.3%). Three of 16 (18.8%) patients undergoing neurosurgery had clinician suspicion of ciTBI <1%.

**CONCLUSIONS:**

The PECARN TBI prediction rules had substantially greater sensitivity, but lower specificity, than clinician suspicion of ciTBI for children with minor blunt head trauma. Because CT ordering did not follow clinician suspicion of <1%, these prediction rules can augment clinician judgment and help obviate CT ordering for children at very low risk of ciTBI.

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[J Pediatr.](https://www.ncbi.nlm.nih.gov/pubmed) 2014 Dec;165(6):1201-1206.e2. doi: 10.1016/j.jpeds.2014.08.008. Epub 2014 Oct 5.

[**Emergency department practice variation in computed tomography use for children with minor blunt head trauma.**](https://www.ncbi.nlm.nih.gov/pubmed/25294604)

[Stanley RM](https://www.ncbi.nlm.nih.gov/pubmed/?term=Stanley%20RM%5BAuthor%5D&cauthor=true&cauthor_uid=25294604)1, [Hoyle JD Jr](https://www.ncbi.nlm.nih.gov/pubmed/?term=Hoyle%20JD%20Jr%5BAuthor%5D&cauthor=true&cauthor_uid=25294604)2, [Dayan PS](https://www.ncbi.nlm.nih.gov/pubmed/?term=Dayan%20PS%5BAuthor%5D&cauthor=true&cauthor_uid=25294604)3, [Atabaki S](https://www.ncbi.nlm.nih.gov/pubmed/?term=Atabaki%20S%5BAuthor%5D&cauthor=true&cauthor_uid=25294604)4, [Lee L](https://www.ncbi.nlm.nih.gov/pubmed/?term=Lee%20L%5BAuthor%5D&cauthor=true&cauthor_uid=25294604)5, [Lillis K](https://www.ncbi.nlm.nih.gov/pubmed/?term=Lillis%20K%5BAuthor%5D&cauthor=true&cauthor_uid=25294604)6, [Gorelick MH](https://www.ncbi.nlm.nih.gov/pubmed/?term=Gorelick%20MH%5BAuthor%5D&cauthor=true&cauthor_uid=25294604)7, [Holubkov R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Holubkov%20R%5BAuthor%5D&cauthor=true&cauthor_uid=25294604)8, [Miskin M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Miskin%20M%5BAuthor%5D&cauthor=true&cauthor_uid=25294604)8, [Holmes JF](https://www.ncbi.nlm.nih.gov/pubmed/?term=Holmes%20JF%5BAuthor%5D&cauthor=true&cauthor_uid=25294604)9, [Dean JM](https://www.ncbi.nlm.nih.gov/pubmed/?term=Dean%20JM%5BAuthor%5D&cauthor=true&cauthor_uid=25294604)8, [Kuppermann N](https://www.ncbi.nlm.nih.gov/pubmed/?term=Kuppermann%20N%5BAuthor%5D&cauthor=true&cauthor_uid=25294604)9; [Pediatric Emergency Care Applied Research Network (PECARN)](https://www.ncbi.nlm.nih.gov/pubmed/?term=Pediatric%20Emergency%20Care%20Applied%20Research%20Network%20(PECARN)%5BCorporate%20Author%5D).

[**Collaborators (109)**](https://www.ncbi.nlm.nih.gov/pubmed)

[Atabaki S](https://www.ncbi.nlm.nih.gov/pubmed/?term=Atabaki%20S), [Babcock-Cimpello L](https://www.ncbi.nlm.nih.gov/pubmed/?term=Babcock-Cimpello%20L), [Bachman M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Bachman%20M), [Badawy M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Badawy%20M), [Bandyopadhyay S](https://www.ncbi.nlm.nih.gov/pubmed/?term=Bandyopadhyay%20S), [Borgialli D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Borgialli%20D), [Brown KM](https://www.ncbi.nlm.nih.gov/pubmed/?term=Brown%20KM), [Callahan J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Callahan%20J), [Cooper A](https://www.ncbi.nlm.nih.gov/pubmed/?term=Cooper%20A), [Dayan PS](https://www.ncbi.nlm.nih.gov/pubmed/?term=Dayan%20PS), [Gerardi MJ](https://www.ncbi.nlm.nih.gov/pubmed/?term=Gerardi%20MJ), [Glass T](https://www.ncbi.nlm.nih.gov/pubmed/?term=Glass%20T), [Gorelick MS](https://www.ncbi.nlm.nih.gov/pubmed/?term=Gorelick%20MS), [Holmes J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Holmes%20J), [Hoyle JD Jr](https://www.ncbi.nlm.nih.gov/pubmed/?term=Hoyle%20JD%20Jr), [Jacobs E](https://www.ncbi.nlm.nih.gov/pubmed/?term=Jacobs%20E), [Jaffe D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Jaffe%20D), [Kuppermann N](https://www.ncbi.nlm.nih.gov/pubmed/?term=Kuppermann%20N), [Lee L](https://www.ncbi.nlm.nih.gov/pubmed/?term=Lee%20L), [Lichenstein R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Lichenstein%20R), [Lillis K](https://www.ncbi.nlm.nih.gov/pubmed/?term=Lillis%20K), [Mahajan P](https://www.ncbi.nlm.nih.gov/pubmed/?term=Mahajan%20P), [Melville K](https://www.ncbi.nlm.nih.gov/pubmed/?term=Melville%20K), [Monroe D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Monroe%20D), [Nadel FM](https://www.ncbi.nlm.nih.gov/pubmed/?term=Nadel%20FM), [Powell E](https://www.ncbi.nlm.nih.gov/pubmed/?term=Powell%20E), [Quayle KS](https://www.ncbi.nlm.nih.gov/pubmed/?term=Quayle%20KS), [Stanley RM](https://www.ncbi.nlm.nih.gov/pubmed/?term=Stanley%20RM), [Schamban N](https://www.ncbi.nlm.nih.gov/pubmed/?term=Schamban%20N), [Schunk J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Schunk%20J), [Tsung J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Tsung%20J), [Tunik M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Tunik%20M), [Kuppermann N](https://www.ncbi.nlm.nih.gov/pubmed/?term=Kuppermann%20N), [Alpern E](https://www.ncbi.nlm.nih.gov/pubmed/?term=Alpern%20E), [Chamberlain J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Chamberlain%20J), [Dean JM](https://www.ncbi.nlm.nih.gov/pubmed/?term=Dean%20JM), [Gerardi MJ](https://www.ncbi.nlm.nih.gov/pubmed/?term=Gerardi%20MJ), [Goepp J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Goepp%20J), [Gorelick MS](https://www.ncbi.nlm.nih.gov/pubmed/?term=Gorelick%20MS), [Hoyle JD Jr](https://www.ncbi.nlm.nih.gov/pubmed/?term=Hoyle%20JD%20Jr), [Jaffe D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Jaffe%20D), [Johns C](https://www.ncbi.nlm.nih.gov/pubmed/?term=Johns%20C), [Levick N](https://www.ncbi.nlm.nih.gov/pubmed/?term=Levick%20N), [Mahajan P](https://www.ncbi.nlm.nih.gov/pubmed/?term=Mahajan%20P), [Maio R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Maio%20R), [Melville K](https://www.ncbi.nlm.nih.gov/pubmed/?term=Melville%20K), [Miller S](https://www.ncbi.nlm.nih.gov/pubmed/?term=Miller%20S), [Monroe D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Monroe%20D), [Ruddy R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Ruddy%20R), [Stanley RM](https://www.ncbi.nlm.nih.gov/pubmed/?term=Stanley%20RM), [Treloar D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Treloar%20D), [Walker A](https://www.ncbi.nlm.nih.gov/pubmed/?term=Walker%20A), [Kavanaugh D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Kavanaugh%20D), [Park HY](https://www.ncbi.nlm.nih.gov/pubmed/?term=Park%20HY), [Dean JM](https://www.ncbi.nlm.nih.gov/pubmed/?term=Dean%20JM), [Holubkov R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Holubkov%20R), [Knight S](https://www.ncbi.nlm.nih.gov/pubmed/?term=Knight%20S), [Donaldson A](https://www.ncbi.nlm.nih.gov/pubmed/?term=Donaldson%20A), [Chamberlain J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Chamberlain%20J), [Brown M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Brown%20M), [Corneli H](https://www.ncbi.nlm.nih.gov/pubmed/?term=Corneli%20H), [Goepp J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Goepp%20J), [Holubkov R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Holubkov%20R), [Mahajan P](https://www.ncbi.nlm.nih.gov/pubmed/?term=Mahajan%20P), [Melville K](https://www.ncbi.nlm.nih.gov/pubmed/?term=Melville%20K), [Frederick P](https://www.ncbi.nlm.nih.gov/pubmed/?term=Frederick%20P), [Stremski E](https://www.ncbi.nlm.nih.gov/pubmed/?term=Stremski%20E), [Tunik M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Tunik%20M), [Gorelick MS](https://www.ncbi.nlm.nih.gov/pubmed/?term=Gorelick%20MS), [Alpern E](https://www.ncbi.nlm.nih.gov/pubmed/?term=Alpern%20E), [Dean JM](https://www.ncbi.nlm.nih.gov/pubmed/?term=Dean%20JM), [Foltin G](https://www.ncbi.nlm.nih.gov/pubmed/?term=Foltin%20G), [Joseph JG](https://www.ncbi.nlm.nih.gov/pubmed/?term=Joseph%20JG), [Miller S](https://www.ncbi.nlm.nih.gov/pubmed/?term=Miller%20S), [Moler F](https://www.ncbi.nlm.nih.gov/pubmed/?term=Moler%20F), [Stanley RM](https://www.ncbi.nlm.nih.gov/pubmed/?term=Stanley%20RM), [Teach S](https://www.ncbi.nlm.nih.gov/pubmed/?term=Teach%20S), [Jaffe D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Jaffe%20D), [Brown K](https://www.ncbi.nlm.nih.gov/pubmed/?term=Brown%20K), [Cooper A](https://www.ncbi.nlm.nih.gov/pubmed/?term=Cooper%20A), [Dean JM](https://www.ncbi.nlm.nih.gov/pubmed/?term=Dean%20JM), [Johns C](https://www.ncbi.nlm.nih.gov/pubmed/?term=Johns%20C), [Maio R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Maio%20R), [Mann C](https://www.ncbi.nlm.nih.gov/pubmed/?term=Mann%20C), [Monroe D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Monroe%20D), [Shaw K](https://www.ncbi.nlm.nih.gov/pubmed/?term=Shaw%20K), [Teitelbaum D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Teitelbaum%20D), [Treloar D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Treloar%20D), [Stanley RM](https://www.ncbi.nlm.nih.gov/pubmed/?term=Stanley%20RM), [Alexander D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Alexander%20D), [Brown J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Brown%20J), [Gerardi MJ](https://www.ncbi.nlm.nih.gov/pubmed/?term=Gerardi%20MJ), [Gregor M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Gregor%20M), [Holubkov R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Holubkov%20R), [Lillis K](https://www.ncbi.nlm.nih.gov/pubmed/?term=Lillis%20K), [Nordberg B](https://www.ncbi.nlm.nih.gov/pubmed/?term=Nordberg%20B), [Ruddy R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Ruddy%20R), [Shults M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Shults%20M), [Walker A](https://www.ncbi.nlm.nih.gov/pubmed/?term=Walker%20A), [Schalick W](https://www.ncbi.nlm.nih.gov/pubmed/?term=Schalick%20W), [Brennan J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Brennan%20J), [Brown J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Brown%20J), [Dean JM](https://www.ncbi.nlm.nih.gov/pubmed/?term=Dean%20JM), [Hoyle J Jr](https://www.ncbi.nlm.nih.gov/pubmed/?term=Hoyle%20J%20Jr), [Levick N](https://www.ncbi.nlm.nih.gov/pubmed/?term=Levick%20N), [Maio R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Maio%20R), [Ruddy R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Ruddy%20R), [Singh-Weik T](https://www.ncbi.nlm.nih.gov/pubmed/?term=Singh-Weik%20T), [Wright J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Wright%20J).

**Abstract**

**OBJECTIVE:**

To describe factors associated with computed tomography (CT) use for children with minor blunt head trauma that are evaluated in emergency departments.

**STUDY DESIGN:**

Planned secondary analysis of a prospective observational study of children <18 years with minor blunt head trauma between 2004 and 2006 at 25 emergency departments. CT scans were obtained at the discretion of treating clinicians. We risk-adjusted patients for clinically important traumatic brain injuries and performed multivariable regression analyses. Outcome measures were rates of CT use by hospital and by clinician training type.

**RESULTS:**

CT rates varied between 19.2% and 69.2% across hospitals. Risk adjustment had little effect on the differential rate of CT use. In low- and middle-risk patients, clinicians obtained CTs more frequently at suburban and nonfreestanding children's hospitals. Physicians with emergency medicine (EM) residency training obtained CTs at greater rates than physicians with pediatric residency or pediatric EM training. In multivariable analyses, compared with pediatric EM-trained physicians, the OR for CT use among EM-trained physicians in children <2 years was 1.24 (95% CI 1.04-1.46), and for children >2 years was 1.68 (95% CI 1.50-1.89). Physicians of all training backgrounds, however, overused CT scans in low-risk children.

**CONCLUSIONS:**

Substantial variation exists in the use of CT for children with minor blunt head trauma not explained by patient severity or rates of positive CT scans or clinically important traumatic brain injuries.

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[Ann Emerg Med.](https://www.ncbi.nlm.nih.gov/pubmed) 2014 Jun;63(6):657-65. doi: 10.1016/j.annemergmed.2014.01.009. Epub 2014 Feb 19.

[**Association of traumatic brain injuries with vomiting in children with blunt head trauma.**](https://www.ncbi.nlm.nih.gov/pubmed/24559605)

[Dayan PS](https://www.ncbi.nlm.nih.gov/pubmed/?term=Dayan%20PS%5BAuthor%5D&cauthor=true&cauthor_uid=24559605)1, [Holmes JF](https://www.ncbi.nlm.nih.gov/pubmed/?term=Holmes%20JF%5BAuthor%5D&cauthor=true&cauthor_uid=24559605)2, [Atabaki S](https://www.ncbi.nlm.nih.gov/pubmed/?term=Atabaki%20S%5BAuthor%5D&cauthor=true&cauthor_uid=24559605)3, [Hoyle J Jr](https://www.ncbi.nlm.nih.gov/pubmed/?term=Hoyle%20J%20Jr%5BAuthor%5D&cauthor=true&cauthor_uid=24559605)4, [Tunik MG](https://www.ncbi.nlm.nih.gov/pubmed/?term=Tunik%20MG%5BAuthor%5D&cauthor=true&cauthor_uid=24559605)5, [Lichenstein R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Lichenstein%20R%5BAuthor%5D&cauthor=true&cauthor_uid=24559605)6, [Alpern E](https://www.ncbi.nlm.nih.gov/pubmed/?term=Alpern%20E%5BAuthor%5D&cauthor=true&cauthor_uid=24559605)7, [Miskin M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Miskin%20M%5BAuthor%5D&cauthor=true&cauthor_uid=24559605)8, [Kuppermann N](https://www.ncbi.nlm.nih.gov/pubmed/?term=Kuppermann%20N%5BAuthor%5D&cauthor=true&cauthor_uid=24559605)9; [Traumatic Brain Injury Study Group of the Pediatric Emergency Care Applied Research Network (PECARN)](https://www.ncbi.nlm.nih.gov/pubmed/?term=Traumatic%20Brain%20Injury%20Study%20Group%20of%20the%20Pediatric%20Emergency%20Care%20Applied%20Research%20Network%20(PECARN)%5BCorporate%20Author%5D).

[**Collaborators (109)**](https://www.ncbi.nlm.nih.gov/pubmed)

[Gerardi M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Gerardi%20M), [Tunik M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Tunik%20M), [Tsung J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Tsung%20J), [Melville K](https://www.ncbi.nlm.nih.gov/pubmed/?term=Melville%20K), [Lee L](https://www.ncbi.nlm.nih.gov/pubmed/?term=Lee%20L), [Mahajan P](https://www.ncbi.nlm.nih.gov/pubmed/?term=Mahajan%20P), [Dayan P](https://www.ncbi.nlm.nih.gov/pubmed/?term=Dayan%20P), [Nadel F](https://www.ncbi.nlm.nih.gov/pubmed/?term=Nadel%20F), [Powell E](https://www.ncbi.nlm.nih.gov/pubmed/?term=Powell%20E), [Atabaki S](https://www.ncbi.nlm.nih.gov/pubmed/?term=Atabaki%20S), [Brown K](https://www.ncbi.nlm.nih.gov/pubmed/?term=Brown%20K), [Glass T](https://www.ncbi.nlm.nih.gov/pubmed/?term=Glass%20T), [Hoyle J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Hoyle%20J), [Cooper A](https://www.ncbi.nlm.nih.gov/pubmed/?term=Cooper%20A), [Jacobs E](https://www.ncbi.nlm.nih.gov/pubmed/?term=Jacobs%20E), [Monroe D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Monroe%20D), [Borgialli D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Borgialli%20D), [Gorelick M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Gorelick%20M), [Bandyopadhyay S](https://www.ncbi.nlm.nih.gov/pubmed/?term=Bandyopadhyay%20S), [Bachman M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Bachman%20M), [Schamban N](https://www.ncbi.nlm.nih.gov/pubmed/?term=Schamban%20N), [Callahan J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Callahan%20J), [Kuppermann N](https://www.ncbi.nlm.nih.gov/pubmed/?term=Kuppermann%20N), [Holmes J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Holmes%20J), [Lichenstein R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Lichenstein%20R), [Stanley R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Stanley%20R), [Badawy M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Badawy%20M), [Babcock-Cimpello L](https://www.ncbi.nlm.nih.gov/pubmed/?term=Babcock-Cimpello%20L), [Schunk J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Schunk%20J), [Quayle K](https://www.ncbi.nlm.nih.gov/pubmed/?term=Quayle%20K), [Jaffe D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Jaffe%20D), [Lillis K](https://www.ncbi.nlm.nih.gov/pubmed/?term=Lillis%20K), [Kuppermann N](https://www.ncbi.nlm.nih.gov/pubmed/?term=Kuppermann%20N), [Alpern E](https://www.ncbi.nlm.nih.gov/pubmed/?term=Alpern%20E), [Chamberlain J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Chamberlain%20J), [Dean J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Dean%20J), [Gerardi M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Gerardi%20M), [Goepp J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Goepp%20J), [Gorelick M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Gorelick%20M), [Hoyle J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Hoyle%20J), [Jaffe D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Jaffe%20D), [Johns C](https://www.ncbi.nlm.nih.gov/pubmed/?term=Johns%20C), [Levick N](https://www.ncbi.nlm.nih.gov/pubmed/?term=Levick%20N), [Mahajan P](https://www.ncbi.nlm.nih.gov/pubmed/?term=Mahajan%20P), [Maio R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Maio%20R), [Melville K](https://www.ncbi.nlm.nih.gov/pubmed/?term=Melville%20K), [Miller S](https://www.ncbi.nlm.nih.gov/pubmed/?term=Miller%20S), [Monroe D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Monroe%20D), [Ruddy R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Ruddy%20R), [Stanley R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Stanley%20R), [Treloar D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Treloar%20D), [Tunik M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Tunik%20M), [Walker A](https://www.ncbi.nlm.nih.gov/pubmed/?term=Walker%20A), [Kavanaugh D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Kavanaugh%20D), [Park H](https://www.ncbi.nlm.nih.gov/pubmed/?term=Park%20H), [Dean M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Dean%20M), [Holubkov R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Holubkov%20R), [Knight S](https://www.ncbi.nlm.nih.gov/pubmed/?term=Knight%20S), [Donaldson A](https://www.ncbi.nlm.nih.gov/pubmed/?term=Donaldson%20A), [Chamberlain J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Chamberlain%20J), [Brown M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Brown%20M), [Corneli H](https://www.ncbi.nlm.nih.gov/pubmed/?term=Corneli%20H), [Goepp J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Goepp%20J), [Holubkov R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Holubkov%20R), [Mahajan P](https://www.ncbi.nlm.nih.gov/pubmed/?term=Mahajan%20P), [Melville K](https://www.ncbi.nlm.nih.gov/pubmed/?term=Melville%20K), [Stremski E](https://www.ncbi.nlm.nih.gov/pubmed/?term=Stremski%20E), [Tunik M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Tunik%20M), [Gorelick M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Gorelick%20M), [Alpern E](https://www.ncbi.nlm.nih.gov/pubmed/?term=Alpern%20E), [Dean J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Dean%20J), [Foltin G](https://www.ncbi.nlm.nih.gov/pubmed/?term=Foltin%20G), [Joseph J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Joseph%20J), [Miller S](https://www.ncbi.nlm.nih.gov/pubmed/?term=Miller%20S), [Moler F](https://www.ncbi.nlm.nih.gov/pubmed/?term=Moler%20F), [Stanley R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Stanley%20R), [Teach S](https://www.ncbi.nlm.nih.gov/pubmed/?term=Teach%20S), [Jaffe D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Jaffe%20D), [Brown K](https://www.ncbi.nlm.nih.gov/pubmed/?term=Brown%20K), [Cooper A](https://www.ncbi.nlm.nih.gov/pubmed/?term=Cooper%20A), [Dean J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Dean%20J), [Johns C](https://www.ncbi.nlm.nih.gov/pubmed/?term=Johns%20C), [Maio R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Maio%20R), [Mann N](https://www.ncbi.nlm.nih.gov/pubmed/?term=Mann%20N), [Monroe D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Monroe%20D), [Shaw K](https://www.ncbi.nlm.nih.gov/pubmed/?term=Shaw%20K), [Teitelbaum D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Teitelbaum%20D), [Treloar D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Treloar%20D), [Stanley R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Stanley%20R), [Alexander D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Alexander%20D), [Brown J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Brown%20J), [Gerardi M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Gerardi%20M), [Gregor M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Gregor%20M), [Holubkov R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Holubkov%20R), [Lillis K](https://www.ncbi.nlm.nih.gov/pubmed/?term=Lillis%20K), [Nordberg B](https://www.ncbi.nlm.nih.gov/pubmed/?term=Nordberg%20B), [Ruddy R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Ruddy%20R), [Shults M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Shults%20M), [Walker A](https://www.ncbi.nlm.nih.gov/pubmed/?term=Walker%20A), [Levick N](https://www.ncbi.nlm.nih.gov/pubmed/?term=Levick%20N), [Brennan J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Brennan%20J), [Brown J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Brown%20J), [Dean J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Dean%20J), [Hoyle J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Hoyle%20J), [Maio R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Maio%20R), [Ruddy R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Ruddy%20R), [Schalick W](https://www.ncbi.nlm.nih.gov/pubmed/?term=Schalick%20W), [Singh T](https://www.ncbi.nlm.nih.gov/pubmed/?term=Singh%20T), [Wright J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Wright%20J).

**Abstract**

**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.

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[Arch Pediatr Adolesc Med.](https://www.ncbi.nlm.nih.gov/pubmed) 2012 Apr;166(4):356-61. doi: 10.1001/archpediatrics.2011.1156. Epub 2011 Dec 5.

[**Prevalence of clinically important traumatic brain injuries in children with minor blunt head trauma and isolated severe injury mechanisms.**](https://www.ncbi.nlm.nih.gov/pubmed/22147762)

[Nigrovic LE](https://www.ncbi.nlm.nih.gov/pubmed/?term=Nigrovic%20LE%5BAuthor%5D&cauthor=true&cauthor_uid=22147762)1, [Lee LK](https://www.ncbi.nlm.nih.gov/pubmed/?term=Lee%20LK%5BAuthor%5D&cauthor=true&cauthor_uid=22147762), [Hoyle J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Hoyle%20J%5BAuthor%5D&cauthor=true&cauthor_uid=22147762), [Stanley RM](https://www.ncbi.nlm.nih.gov/pubmed/?term=Stanley%20RM%5BAuthor%5D&cauthor=true&cauthor_uid=22147762), [Gorelick MH](https://www.ncbi.nlm.nih.gov/pubmed/?term=Gorelick%20MH%5BAuthor%5D&cauthor=true&cauthor_uid=22147762), [Miskin M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Miskin%20M%5BAuthor%5D&cauthor=true&cauthor_uid=22147762), [Atabaki SM](https://www.ncbi.nlm.nih.gov/pubmed/?term=Atabaki%20SM%5BAuthor%5D&cauthor=true&cauthor_uid=22147762), [Dayan PS](https://www.ncbi.nlm.nih.gov/pubmed/?term=Dayan%20PS%5BAuthor%5D&cauthor=true&cauthor_uid=22147762), [Holmes JF](https://www.ncbi.nlm.nih.gov/pubmed/?term=Holmes%20JF%5BAuthor%5D&cauthor=true&cauthor_uid=22147762), [Kuppermann N](https://www.ncbi.nlm.nih.gov/pubmed/?term=Kuppermann%20N%5BAuthor%5D&cauthor=true&cauthor_uid=22147762); [Traumatic Brain Injury (TBI) Working Group of Pediatric Emergency Care Applied Research Network (PECARN)](https://www.ncbi.nlm.nih.gov/pubmed/?term=Traumatic%20Brain%20Injury%20(TBI)%20Working%20Group%20of%20Pediatric%20Emergency%20Care%20Applied%20Research%20Network%20(PECARN)%5BCorporate%20Author%5D).

[**Collaborators (83)**](https://www.ncbi.nlm.nih.gov/pubmed)

[Gerardi M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Gerardi%20M), [Tunik M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Tunik%20M), [Tsung J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Tsung%20J), [Melville K](https://www.ncbi.nlm.nih.gov/pubmed/?term=Melville%20K), [Lee L](https://www.ncbi.nlm.nih.gov/pubmed/?term=Lee%20L), [Lillis K](https://www.ncbi.nlm.nih.gov/pubmed/?term=Lillis%20K), [Mahajan P](https://www.ncbi.nlm.nih.gov/pubmed/?term=Mahajan%20P), [Dayan P](https://www.ncbi.nlm.nih.gov/pubmed/?term=Dayan%20P), [Nadel F](https://www.ncbi.nlm.nih.gov/pubmed/?term=Nadel%20F), [Powell E](https://www.ncbi.nlm.nih.gov/pubmed/?term=Powell%20E), [Atabaki S](https://www.ncbi.nlm.nih.gov/pubmed/?term=Atabaki%20S), [Brown K](https://www.ncbi.nlm.nih.gov/pubmed/?term=Brown%20K), [Glass T](https://www.ncbi.nlm.nih.gov/pubmed/?term=Glass%20T), [Hoyle J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Hoyle%20J), [Cooper A](https://www.ncbi.nlm.nih.gov/pubmed/?term=Cooper%20A), [Jacobs E](https://www.ncbi.nlm.nih.gov/pubmed/?term=Jacobs%20E), [Monroe D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Monroe%20D), [Borgialli D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Borgialli%20D), [Gorelick M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Gorelick%20M), [Bandyopadhyay S](https://www.ncbi.nlm.nih.gov/pubmed/?term=Bandyopadhyay%20S), [Bachman M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Bachman%20M), [Schamban N](https://www.ncbi.nlm.nih.gov/pubmed/?term=Schamban%20N), [Callahan J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Callahan%20J), [Kuppermann N](https://www.ncbi.nlm.nih.gov/pubmed/?term=Kuppermann%20N), [Holmes J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Holmes%20J), [Lichenstein R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Lichenstein%20R), [Stanley R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Stanley%20R), [Badawy M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Badawy%20M), [Babcock-Cimpello L](https://www.ncbi.nlm.nih.gov/pubmed/?term=Babcock-Cimpello%20L), [Schunk J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Schunk%20J), [Quayle K](https://www.ncbi.nlm.nih.gov/pubmed/?term=Quayle%20K), [Jaffe D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Jaffe%20D), [Alpern E](https://www.ncbi.nlm.nih.gov/pubmed/?term=Alpern%20E), [Chamberlain J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Chamberlain%20J), [Dean JM](https://www.ncbi.nlm.nih.gov/pubmed/?term=Dean%20JM), [Gerardi M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Gerardi%20M), [Goepp J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Goepp%20J), [Gorelick M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Gorelick%20M), [Hoyle J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Hoyle%20J), [Jaffe D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Jaffe%20D), [Johns C](https://www.ncbi.nlm.nih.gov/pubmed/?term=Johns%20C), [Levick N](https://www.ncbi.nlm.nih.gov/pubmed/?term=Levick%20N), [Mahajan P](https://www.ncbi.nlm.nih.gov/pubmed/?term=Mahajan%20P), [Maio R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Maio%20R), [Melville K](https://www.ncbi.nlm.nih.gov/pubmed/?term=Melville%20K), [Miller S](https://www.ncbi.nlm.nih.gov/pubmed/?term=Miller%20S), [Monroe D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Monroe%20D), [Ruddy R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Ruddy%20R), [Stanley R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Stanley%20R), [Treloar D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Treloar%20D), [Tunik M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Tunik%20M), [Walker A](https://www.ncbi.nlm.nih.gov/pubmed/?term=Walker%20A), [Kavanaugh D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Kavanaugh%20D), [Park H](https://www.ncbi.nlm.nih.gov/pubmed/?term=Park%20H), [Dean M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Dean%20M), [Holubkov R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Holubkov%20R), [Knight S](https://www.ncbi.nlm.nih.gov/pubmed/?term=Knight%20S), [Donaldson A](https://www.ncbi.nlm.nih.gov/pubmed/?term=Donaldson%20A), [Corneli H](https://www.ncbi.nlm.nih.gov/pubmed/?term=Corneli%20H), [Stremski E](https://www.ncbi.nlm.nih.gov/pubmed/?term=Stremski%20E), [Tunik M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Tunik%20M), [Foltin G](https://www.ncbi.nlm.nih.gov/pubmed/?term=Foltin%20G), [Joseph J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Joseph%20J), [Moler F](https://www.ncbi.nlm.nih.gov/pubmed/?term=Moler%20F), [Stanley R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Stanley%20R), [Teach S](https://www.ncbi.nlm.nih.gov/pubmed/?term=Teach%20S), [Maio R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Maio%20R), [Mann NC](https://www.ncbi.nlm.nih.gov/pubmed/?term=Mann%20NC), [Monroe D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Monroe%20D), [Shaw K](https://www.ncbi.nlm.nih.gov/pubmed/?term=Shaw%20K), [Teitelbaum D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Teitelbaum%20D), [Treloar D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Treloar%20D), [Stanley R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Stanley%20R), [Alexander D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Alexander%20D), [Nordberg B](https://www.ncbi.nlm.nih.gov/pubmed/?term=Nordberg%20B), [Ruddy R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Ruddy%20R), [Shults M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Shults%20M), [Walker A](https://www.ncbi.nlm.nih.gov/pubmed/?term=Walker%20A), [Levick N](https://www.ncbi.nlm.nih.gov/pubmed/?term=Levick%20N), [Brennan J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Brennan%20J), [Schalick W](https://www.ncbi.nlm.nih.gov/pubmed/?term=Schalick%20W), [Singh T](https://www.ncbi.nlm.nih.gov/pubmed/?term=Singh%20T), [Wright J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Wright%20J).

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**Erratum in**

* Arch Pediatr Adolesc Med. 2014 Jun;168(6):586.

**Abstract**

**OBJECTIVE:**

To determine the prevalence of clinically important traumatic brain injuries (TBIs) with severe injury mechanisms in children with minor blunt head trauma but with no other risk factors from the Pediatric Emergency Care Applied Research Network (PECARN) TBI prediction rules (defined as isolated severe injury mechanisms).

**DESIGN:**

Secondary analysis of a large prospective observational cohort study.

**SETTING:**

Twenty-five emergency departments participating in the PECARN.

**PATIENTS:**

Children with minor blunt head trauma and Glasgow Coma Scale scores of at least 14.

**INTERVENTION:**

Treating clinicians completed a structured data form that included injury mechanism (severity categories defined a priori).

**MAIN OUTCOME MEASURES:**

Clinically important TBIs were defined as intracranial injuries resulting in death, neurosurgical intervention, intubation for more than 24 hours, or hospital admission for at least 2 nights. We investigated the rate of clinically important TBIs in children with either severe injury mechanisms or isolated severe injury mechanisms.

**RESULTS:**

Of the 42,412 patients enrolled in the overall study, 42,099 (99%) had injury mechanisms recorded, and their data were included for analysis. Of all study patients, 5869 (14%) had severe injury mechanisms, and 3302 (8%) had isolated severe injury mechanisms. Overall, 367 children had clinically important TBIs (0.9%; 95% CI, 0.8%-1.0%). Of the 1327 children younger than 2 years with isolated severe injury mechanisms, 4 (0.3%; 95% CI, 0.1%-0.8%) had clinically important TBIs, as did 12 of the 1975 children 2 years or older (0.6%; 95% CI, 0.3%-1.1%).

**CONCLUSION:**

Children with isolated severe injury mechanisms are at low risk of clinically important TBI, and many do not require emergent neuroimaging.

Select item 216834747.

[Ann Emerg Med.](https://www.ncbi.nlm.nih.gov/pubmed) 2011 Oct;58(4):315-22. doi: 10.1016/j.annemergmed.2011.03.060. Epub 2011 Jun 16.

[**Do children with blunt head trauma and normal cranial computed tomography scan results require hospitalization for neurologic observation?**](https://www.ncbi.nlm.nih.gov/pubmed/21683474)

[Holmes JF](https://www.ncbi.nlm.nih.gov/pubmed/?term=Holmes%20JF%5BAuthor%5D&cauthor=true&cauthor_uid=21683474)1, [Borgialli DA](https://www.ncbi.nlm.nih.gov/pubmed/?term=Borgialli%20DA%5BAuthor%5D&cauthor=true&cauthor_uid=21683474), [Nadel FM](https://www.ncbi.nlm.nih.gov/pubmed/?term=Nadel%20FM%5BAuthor%5D&cauthor=true&cauthor_uid=21683474), [Quayle KS](https://www.ncbi.nlm.nih.gov/pubmed/?term=Quayle%20KS%5BAuthor%5D&cauthor=true&cauthor_uid=21683474), [Schambam N](https://www.ncbi.nlm.nih.gov/pubmed/?term=Schambam%20N%5BAuthor%5D&cauthor=true&cauthor_uid=21683474), [Cooper A](https://www.ncbi.nlm.nih.gov/pubmed/?term=Cooper%20A%5BAuthor%5D&cauthor=true&cauthor_uid=21683474), [Schunk JE](https://www.ncbi.nlm.nih.gov/pubmed/?term=Schunk%20JE%5BAuthor%5D&cauthor=true&cauthor_uid=21683474), [Miskin ML](https://www.ncbi.nlm.nih.gov/pubmed/?term=Miskin%20ML%5BAuthor%5D&cauthor=true&cauthor_uid=21683474), [Atabaki SM](https://www.ncbi.nlm.nih.gov/pubmed/?term=Atabaki%20SM%5BAuthor%5D&cauthor=true&cauthor_uid=21683474), [Hoyle JD](https://www.ncbi.nlm.nih.gov/pubmed/?term=Hoyle%20JD%5BAuthor%5D&cauthor=true&cauthor_uid=21683474), [Dayan PS](https://www.ncbi.nlm.nih.gov/pubmed/?term=Dayan%20PS%5BAuthor%5D&cauthor=true&cauthor_uid=21683474), [Kuppermann N](https://www.ncbi.nlm.nih.gov/pubmed/?term=Kuppermann%20N%5BAuthor%5D&cauthor=true&cauthor_uid=21683474); [TBI Study Group for the Pediatric Emergency Care Applied Research Network](https://www.ncbi.nlm.nih.gov/pubmed/?term=TBI%20Study%20Group%20for%20the%20Pediatric%20Emergency%20Care%20Applied%20Research%20Network%5BCorporate%20Author%5D).

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[Kuppermann N](https://www.ncbi.nlm.nih.gov/pubmed/?term=Kuppermann%20N), [Alpern E](https://www.ncbi.nlm.nih.gov/pubmed/?term=Alpern%20E), [Chamberlain J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Chamberlain%20J), [Dean J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Dean%20J), [Gerardi M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Gerardi%20M), [Goepp J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Goepp%20J), [Gorelick M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Gorelick%20M), [Hoyle J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Hoyle%20J), [Jaffe D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Jaffe%20D), [Johns C](https://www.ncbi.nlm.nih.gov/pubmed/?term=Johns%20C), [Levick N](https://www.ncbi.nlm.nih.gov/pubmed/?term=Levick%20N), [Mahajan P](https://www.ncbi.nlm.nih.gov/pubmed/?term=Mahajan%20P), [Maio R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Maio%20R), [Melville K](https://www.ncbi.nlm.nih.gov/pubmed/?term=Melville%20K), [Miller S](https://www.ncbi.nlm.nih.gov/pubmed/?term=Miller%20S), [Monroe D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Monroe%20D), [Ruddy R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Ruddy%20R), [Stanley R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Stanley%20R), [Treloar D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Treloar%20D), [Tunik M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Tunik%20M), [Walker A](https://www.ncbi.nlm.nih.gov/pubmed/?term=Walker%20A), [Kavanaugh D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Kavanaugh%20D), [Park H](https://www.ncbi.nlm.nih.gov/pubmed/?term=Park%20H), [Dean M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Dean%20M), [Holubkov R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Holubkov%20R), [Knight S](https://www.ncbi.nlm.nih.gov/pubmed/?term=Knight%20S), [Donaldson A](https://www.ncbi.nlm.nih.gov/pubmed/?term=Donaldson%20A), [Chamberlain J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Chamberlain%20J), [Brown M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Brown%20M), [Corneli H](https://www.ncbi.nlm.nih.gov/pubmed/?term=Corneli%20H), [Goepp J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Goepp%20J), [Holubkov R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Holubkov%20R), [Mahajan P](https://www.ncbi.nlm.nih.gov/pubmed/?term=Mahajan%20P), [Melville K](https://www.ncbi.nlm.nih.gov/pubmed/?term=Melville%20K), [Stremski E](https://www.ncbi.nlm.nih.gov/pubmed/?term=Stremski%20E), [Tunik M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Tunik%20M), [Gorelick M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Gorelick%20M), [Alpern E](https://www.ncbi.nlm.nih.gov/pubmed/?term=Alpern%20E), [Dean J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Dean%20J), [Foltin G](https://www.ncbi.nlm.nih.gov/pubmed/?term=Foltin%20G), [Joseph J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Joseph%20J), [Miller S](https://www.ncbi.nlm.nih.gov/pubmed/?term=Miller%20S), [Moler F](https://www.ncbi.nlm.nih.gov/pubmed/?term=Moler%20F), [Stanley R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Stanley%20R), [Teach S](https://www.ncbi.nlm.nih.gov/pubmed/?term=Teach%20S), [Jaffe D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Jaffe%20D), [Brown K](https://www.ncbi.nlm.nih.gov/pubmed/?term=Brown%20K), [Cooper A](https://www.ncbi.nlm.nih.gov/pubmed/?term=Cooper%20A), [Dean J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Dean%20J), [Johns C](https://www.ncbi.nlm.nih.gov/pubmed/?term=Johns%20C), [Maio R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Maio%20R), [Mann N](https://www.ncbi.nlm.nih.gov/pubmed/?term=Mann%20N), [Monroe D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Monroe%20D), [Shaw K](https://www.ncbi.nlm.nih.gov/pubmed/?term=Shaw%20K), [Teitelbaum D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Teitelbaum%20D), [Treloar D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Treloar%20D), [Stanley R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Stanley%20R), [Alexander D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Alexander%20D), [Brown J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Brown%20J), [Gerardi M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Gerardi%20M), [Gregor M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Gregor%20M), [Holubkov R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Holubkov%20R), [Lillis K](https://www.ncbi.nlm.nih.gov/pubmed/?term=Lillis%20K), [Nordberg B](https://www.ncbi.nlm.nih.gov/pubmed/?term=Nordberg%20B), [Ruddy R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Ruddy%20R), [Shults M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Shults%20M), [Walker A](https://www.ncbi.nlm.nih.gov/pubmed/?term=Walker%20A), [Levick N](https://www.ncbi.nlm.nih.gov/pubmed/?term=Levick%20N), [Brennan J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Brennan%20J), [Brown J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Brown%20J), [Dean J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Dean%20J), [Hoyle J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Hoyle%20J), [Maio R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Maio%20R), [Ruddy R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Ruddy%20R), [Schalick W](https://www.ncbi.nlm.nih.gov/pubmed/?term=Schalick%20W), [Singh T](https://www.ncbi.nlm.nih.gov/pubmed/?term=Singh%20T), [Wright J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Wright%20J), [Gerardi M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Gerardi%20M), [Tunik M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Tunik%20M), [Tsung J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Tsung%20J), [Melville K](https://www.ncbi.nlm.nih.gov/pubmed/?term=Melville%20K), [Lee L](https://www.ncbi.nlm.nih.gov/pubmed/?term=Lee%20L), [Mahajan P](https://www.ncbi.nlm.nih.gov/pubmed/?term=Mahajan%20P), [Dayan P](https://www.ncbi.nlm.nih.gov/pubmed/?term=Dayan%20P), [Nadel F](https://www.ncbi.nlm.nih.gov/pubmed/?term=Nadel%20F), [Powell E](https://www.ncbi.nlm.nih.gov/pubmed/?term=Powell%20E), [Atabaki S](https://www.ncbi.nlm.nih.gov/pubmed/?term=Atabaki%20S), [Brown K](https://www.ncbi.nlm.nih.gov/pubmed/?term=Brown%20K), [Glass T](https://www.ncbi.nlm.nih.gov/pubmed/?term=Glass%20T), [Hoyle J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Hoyle%20J), [Cooper A](https://www.ncbi.nlm.nih.gov/pubmed/?term=Cooper%20A), [Jacobs E](https://www.ncbi.nlm.nih.gov/pubmed/?term=Jacobs%20E), [Monroe D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Monroe%20D), [Borgialli D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Borgialli%20D), [Gorelick M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Gorelick%20M), [Bandyopadhyay S](https://www.ncbi.nlm.nih.gov/pubmed/?term=Bandyopadhyay%20S), [Bachman M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Bachman%20M), [Schamban N](https://www.ncbi.nlm.nih.gov/pubmed/?term=Schamban%20N), [Callahan J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Callahan%20J), [Kuppermann N](https://www.ncbi.nlm.nih.gov/pubmed/?term=Kuppermann%20N), [Holmes J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Holmes%20J), [Lichenstein R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Lichenstein%20R), [Stanley R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Stanley%20R), [Badawy M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Badawy%20M), [Babcock-Cimpello L](https://www.ncbi.nlm.nih.gov/pubmed/?term=Babcock-Cimpello%20L), [Schunk J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Schunk%20J), [Quayle K](https://www.ncbi.nlm.nih.gov/pubmed/?term=Quayle%20K), [Jaffe D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Jaffe%20D), [Lillis K](https://www.ncbi.nlm.nih.gov/pubmed/?term=Lillis%20K).

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**Abstract**

**STUDY OBJECTIVE:**

Children evaluated in the emergency department (ED) with minor blunt head trauma, defined by initial Glasgow Coma Scale (GCS) scores of 14 or 15, are frequently hospitalized despite normal cranial computed tomography (CT) scan results. We seek to identify the frequency of neurologic complications in children with minor blunt head trauma and normal ED CT scan results.

**METHODS:**

We conducted a prospective, multicenter observational cohort study of children younger than 18 years with blunt head trauma (including isolated head or multisystem trauma) at 25 centers between 2004 and 2006. In this substudy, we analyzed individuals with initial GCS scores of 14 or 15 who had normal cranial CT scan results during ED evaluation. An abnormal imaging study result was defined by any intracranial hemorrhage, cerebral edema, pneumocephalus, or any skull fracture. Patients with normal CT scan results who were hospitalized were followed to determine neurologic outcomes; those discharged to home from the ED received telephone/mail follow-up to assess for subsequent neuroimaging, neurologic complications, or neurosurgical intervention.

**RESULTS:**

Children (13,543) with GCS scores of 14 or 15 and normal ED CT scan results were enrolled, including 12,584 (93%) with GCS scores of 15 and 959 (7%) with GCS scores of 14. Of 13,543 patients, 2,485 (18%) were hospitalized, including 2,107 of 12,584 (17%) with GCS scores of 15 and 378 of 959 (39%) with GCS scores of 14. Of the 11,058 patients discharged home from the ED, successful telephone/mail follow-up was completed for 8,756 (79%), and medical record, continuous quality improvement, and morgue review was performed for the remaining patients. One hundred ninety-seven (2%) children received subsequent CT or magnetic resonance imaging (MRI); 5 (0.05%) had abnormal CT/MRI scan results and none (0%; 95% confidence interval [CI] 0% to 0.03%) received a neurosurgical intervention. Of the 2,485 hospitalized patients, 137 (6%) received subsequent CT or MRI; 16 (0.6%) had abnormal CT/MRI scan results and none (0%; 95% CI 0% to 0.2%) received a neurosurgical intervention. The negative predictive value for neurosurgical intervention for a child with an initial GCS score of 14 or 15 and a normal CT scan result was 100% (95% CI 99.97% to 100%).

**CONCLUSION:**

Children with blunt head trauma and initial ED GCS scores of 14 or 15 and normal cranial CT scan results are at very low risk for subsequent traumatic findings on neuroimaging and extremely low risk of needing neurosurgical intervention. Hospitalization of children with minor head trauma after normal CT scan results for neurologic observation is generally unnecessary.

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* [Children with minor blunt head trauma, a Glasgow Coma Scale score of 14 or 15 and a normal CT scan are at very low risk of traumatic findings on subsequent neuroimaging or of requiring neurosurgical intervention.](https://www.ncbi.nlm.nih.gov/pubmed/22511645) [Evid Based Med. 2012]

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[Lancet.](https://www.ncbi.nlm.nih.gov/pubmed) 2009 Oct 3;374(9696):1160-70. doi: 10.1016/S0140-6736(09)61558-0. Epub 2009 Sep 14.

[**Identification of children at very low risk of clinically-important brain injuries after head trauma: a prospective cohort study.**](https://www.ncbi.nlm.nih.gov/pubmed/19758692)

[Kuppermann N](https://www.ncbi.nlm.nih.gov/pubmed/?term=Kuppermann%20N%5BAuthor%5D&cauthor=true&cauthor_uid=19758692)1, [Holmes JF](https://www.ncbi.nlm.nih.gov/pubmed/?term=Holmes%20JF%5BAuthor%5D&cauthor=true&cauthor_uid=19758692), [Dayan PS](https://www.ncbi.nlm.nih.gov/pubmed/?term=Dayan%20PS%5BAuthor%5D&cauthor=true&cauthor_uid=19758692), [Hoyle JD Jr](https://www.ncbi.nlm.nih.gov/pubmed/?term=Hoyle%20JD%20Jr%5BAuthor%5D&cauthor=true&cauthor_uid=19758692), [Atabaki SM](https://www.ncbi.nlm.nih.gov/pubmed/?term=Atabaki%20SM%5BAuthor%5D&cauthor=true&cauthor_uid=19758692), [Holubkov R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Holubkov%20R%5BAuthor%5D&cauthor=true&cauthor_uid=19758692), [Nadel FM](https://www.ncbi.nlm.nih.gov/pubmed/?term=Nadel%20FM%5BAuthor%5D&cauthor=true&cauthor_uid=19758692), [Monroe D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Monroe%20D%5BAuthor%5D&cauthor=true&cauthor_uid=19758692), [Stanley RM](https://www.ncbi.nlm.nih.gov/pubmed/?term=Stanley%20RM%5BAuthor%5D&cauthor=true&cauthor_uid=19758692), [Borgialli DA](https://www.ncbi.nlm.nih.gov/pubmed/?term=Borgialli%20DA%5BAuthor%5D&cauthor=true&cauthor_uid=19758692), [Badawy MK](https://www.ncbi.nlm.nih.gov/pubmed/?term=Badawy%20MK%5BAuthor%5D&cauthor=true&cauthor_uid=19758692), [Schunk JE](https://www.ncbi.nlm.nih.gov/pubmed/?term=Schunk%20JE%5BAuthor%5D&cauthor=true&cauthor_uid=19758692), [Quayle KS](https://www.ncbi.nlm.nih.gov/pubmed/?term=Quayle%20KS%5BAuthor%5D&cauthor=true&cauthor_uid=19758692), [Mahajan P](https://www.ncbi.nlm.nih.gov/pubmed/?term=Mahajan%20P%5BAuthor%5D&cauthor=true&cauthor_uid=19758692), [Lichenstein R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Lichenstein%20R%5BAuthor%5D&cauthor=true&cauthor_uid=19758692), [Lillis KA](https://www.ncbi.nlm.nih.gov/pubmed/?term=Lillis%20KA%5BAuthor%5D&cauthor=true&cauthor_uid=19758692), [Tunik MG](https://www.ncbi.nlm.nih.gov/pubmed/?term=Tunik%20MG%5BAuthor%5D&cauthor=true&cauthor_uid=19758692), [Jacobs ES](https://www.ncbi.nlm.nih.gov/pubmed/?term=Jacobs%20ES%5BAuthor%5D&cauthor=true&cauthor_uid=19758692), [Callahan JM](https://www.ncbi.nlm.nih.gov/pubmed/?term=Callahan%20JM%5BAuthor%5D&cauthor=true&cauthor_uid=19758692), [Gorelick MH](https://www.ncbi.nlm.nih.gov/pubmed/?term=Gorelick%20MH%5BAuthor%5D&cauthor=true&cauthor_uid=19758692), [Glass TF](https://www.ncbi.nlm.nih.gov/pubmed/?term=Glass%20TF%5BAuthor%5D&cauthor=true&cauthor_uid=19758692), [Lee LK](https://www.ncbi.nlm.nih.gov/pubmed/?term=Lee%20LK%5BAuthor%5D&cauthor=true&cauthor_uid=19758692), [Bachman MC](https://www.ncbi.nlm.nih.gov/pubmed/?term=Bachman%20MC%5BAuthor%5D&cauthor=true&cauthor_uid=19758692), [Cooper A](https://www.ncbi.nlm.nih.gov/pubmed/?term=Cooper%20A%5BAuthor%5D&cauthor=true&cauthor_uid=19758692), [Powell EC](https://www.ncbi.nlm.nih.gov/pubmed/?term=Powell%20EC%5BAuthor%5D&cauthor=true&cauthor_uid=19758692), [Gerardi MJ](https://www.ncbi.nlm.nih.gov/pubmed/?term=Gerardi%20MJ%5BAuthor%5D&cauthor=true&cauthor_uid=19758692), [Melville KA](https://www.ncbi.nlm.nih.gov/pubmed/?term=Melville%20KA%5BAuthor%5D&cauthor=true&cauthor_uid=19758692), [Muizelaar JP](https://www.ncbi.nlm.nih.gov/pubmed/?term=Muizelaar%20JP%5BAuthor%5D&cauthor=true&cauthor_uid=19758692), [Wisner DH](https://www.ncbi.nlm.nih.gov/pubmed/?term=Wisner%20DH%5BAuthor%5D&cauthor=true&cauthor_uid=19758692), [Zuspan SJ](https://www.ncbi.nlm.nih.gov/pubmed/?term=Zuspan%20SJ%5BAuthor%5D&cauthor=true&cauthor_uid=19758692), [Dean JM](https://www.ncbi.nlm.nih.gov/pubmed/?term=Dean%20JM%5BAuthor%5D&cauthor=true&cauthor_uid=19758692), [Wootton-Gorges SL](https://www.ncbi.nlm.nih.gov/pubmed/?term=Wootton-Gorges%20SL%5BAuthor%5D&cauthor=true&cauthor_uid=19758692); [Pediatric Emergency Care Applied Research Network (PECARN)](https://www.ncbi.nlm.nih.gov/pubmed/?term=Pediatric%20Emergency%20Care%20Applied%20Research%20Network%20(PECARN)%5BCorporate%20Author%5D).

[**Collaborators (109)**](https://www.ncbi.nlm.nih.gov/pubmed)

[Gerardi M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Gerardi%20M), [Tunik M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Tunik%20M), [Tsung J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Tsung%20J), [Melville K](https://www.ncbi.nlm.nih.gov/pubmed/?term=Melville%20K), [Lee L](https://www.ncbi.nlm.nih.gov/pubmed/?term=Lee%20L), [Lillis K](https://www.ncbi.nlm.nih.gov/pubmed/?term=Lillis%20K), [Mahajan P](https://www.ncbi.nlm.nih.gov/pubmed/?term=Mahajan%20P), [Dayan P](https://www.ncbi.nlm.nih.gov/pubmed/?term=Dayan%20P), [Nadel F](https://www.ncbi.nlm.nih.gov/pubmed/?term=Nadel%20F), [Powell E](https://www.ncbi.nlm.nih.gov/pubmed/?term=Powell%20E), [Atabaki S](https://www.ncbi.nlm.nih.gov/pubmed/?term=Atabaki%20S), [Brown K](https://www.ncbi.nlm.nih.gov/pubmed/?term=Brown%20K), [Glass T](https://www.ncbi.nlm.nih.gov/pubmed/?term=Glass%20T), [Hoyle J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Hoyle%20J), [Cooper A](https://www.ncbi.nlm.nih.gov/pubmed/?term=Cooper%20A), [Jacobs E](https://www.ncbi.nlm.nih.gov/pubmed/?term=Jacobs%20E), [Monroe D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Monroe%20D), [Borgialli D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Borgialli%20D), [Gorelick M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Gorelick%20M), [Bandyopadhyay S](https://www.ncbi.nlm.nih.gov/pubmed/?term=Bandyopadhyay%20S), [Bachman M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Bachman%20M), [Schamban N](https://www.ncbi.nlm.nih.gov/pubmed/?term=Schamban%20N), [Callahan J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Callahan%20J), [Kuppermann N](https://www.ncbi.nlm.nih.gov/pubmed/?term=Kuppermann%20N), [Holmes J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Holmes%20J), [Lichenstein R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Lichenstein%20R), [Stanley R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Stanley%20R), [Badawy M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Badawy%20M), [Babcock-Cimpello L](https://www.ncbi.nlm.nih.gov/pubmed/?term=Babcock-Cimpello%20L), [Schunk J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Schunk%20J), [Quayle K](https://www.ncbi.nlm.nih.gov/pubmed/?term=Quayle%20K), [Jaffe D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Jaffe%20D), [Kuppermann N](https://www.ncbi.nlm.nih.gov/pubmed/?term=Kuppermann%20N), [Alpern E](https://www.ncbi.nlm.nih.gov/pubmed/?term=Alpern%20E), [Chamberlain J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Chamberlain%20J), [Dean JM](https://www.ncbi.nlm.nih.gov/pubmed/?term=Dean%20JM), [Gerardi M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Gerardi%20M), [Goepp J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Goepp%20J), [Gorelick M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Gorelick%20M), [Hoyle J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Hoyle%20J), [Jaffe D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Jaffe%20D), [Johns C](https://www.ncbi.nlm.nih.gov/pubmed/?term=Johns%20C), [Levick N](https://www.ncbi.nlm.nih.gov/pubmed/?term=Levick%20N), [Mahajan P](https://www.ncbi.nlm.nih.gov/pubmed/?term=Mahajan%20P), [Maio R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Maio%20R), [Melville K](https://www.ncbi.nlm.nih.gov/pubmed/?term=Melville%20K), [Miller S](https://www.ncbi.nlm.nih.gov/pubmed/?term=Miller%20S), [Monroe D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Monroe%20D), [Ruddy R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Ruddy%20R), [Stanley R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Stanley%20R), [Treloar D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Treloar%20D), [Tunik M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Tunik%20M), [Walker A](https://www.ncbi.nlm.nih.gov/pubmed/?term=Walker%20A), [Kavanaugh D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Kavanaugh%20D), [Park H](https://www.ncbi.nlm.nih.gov/pubmed/?term=Park%20H), [Dean M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Dean%20M), [Holubkov R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Holubkov%20R), [Knight S](https://www.ncbi.nlm.nih.gov/pubmed/?term=Knight%20S), [Donaldson A](https://www.ncbi.nlm.nih.gov/pubmed/?term=Donaldson%20A), [Chamberlain J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Chamberlain%20J), [Brown M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Brown%20M), [Corneli H](https://www.ncbi.nlm.nih.gov/pubmed/?term=Corneli%20H), [Goepp J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Goepp%20J), [Holubkov R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Holubkov%20R), [Mahajan P](https://www.ncbi.nlm.nih.gov/pubmed/?term=Mahajan%20P), [Melville K](https://www.ncbi.nlm.nih.gov/pubmed/?term=Melville%20K), [Stremski E](https://www.ncbi.nlm.nih.gov/pubmed/?term=Stremski%20E), [Tunik M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Tunik%20M), [Gorelick M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Gorelick%20M), [Alpern E](https://www.ncbi.nlm.nih.gov/pubmed/?term=Alpern%20E), [Dean JM](https://www.ncbi.nlm.nih.gov/pubmed/?term=Dean%20JM), [Foltin G](https://www.ncbi.nlm.nih.gov/pubmed/?term=Foltin%20G), [Joseph J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Joseph%20J), [Miller S](https://www.ncbi.nlm.nih.gov/pubmed/?term=Miller%20S), [Moler F](https://www.ncbi.nlm.nih.gov/pubmed/?term=Moler%20F), [Stanley R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Stanley%20R), [Teach S](https://www.ncbi.nlm.nih.gov/pubmed/?term=Teach%20S), [Jaffe D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Jaffe%20D), [Brown K](https://www.ncbi.nlm.nih.gov/pubmed/?term=Brown%20K), [Cooper A](https://www.ncbi.nlm.nih.gov/pubmed/?term=Cooper%20A), [Dean JM](https://www.ncbi.nlm.nih.gov/pubmed/?term=Dean%20JM), [Johns C](https://www.ncbi.nlm.nih.gov/pubmed/?term=Johns%20C), [Maio R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Maio%20R), [Mann NC](https://www.ncbi.nlm.nih.gov/pubmed/?term=Mann%20NC), [Monroe D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Monroe%20D), [Shaw K](https://www.ncbi.nlm.nih.gov/pubmed/?term=Shaw%20K), [Teitelbaum D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Teitelbaum%20D), [Treloar D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Treloar%20D), [Stanley R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Stanley%20R), [Alexander D](https://www.ncbi.nlm.nih.gov/pubmed/?term=Alexander%20D), [Brown J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Brown%20J), [Gerardi M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Gerardi%20M), [Gregor M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Gregor%20M), [Holubkov R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Holubkov%20R), [Lillis K](https://www.ncbi.nlm.nih.gov/pubmed/?term=Lillis%20K), [Nordberg B](https://www.ncbi.nlm.nih.gov/pubmed/?term=Nordberg%20B), [Ruddy R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Ruddy%20R), [Shults M](https://www.ncbi.nlm.nih.gov/pubmed/?term=Shults%20M), [Walker A](https://www.ncbi.nlm.nih.gov/pubmed/?term=Walker%20A), [Levick N](https://www.ncbi.nlm.nih.gov/pubmed/?term=Levick%20N), [Brennan J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Brennan%20J), [Brown J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Brown%20J), [Dean JM](https://www.ncbi.nlm.nih.gov/pubmed/?term=Dean%20JM), [Hoyle J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Hoyle%20J), [Maio R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Maio%20R), [Ruddy R](https://www.ncbi.nlm.nih.gov/pubmed/?term=Ruddy%20R), [Schalick W](https://www.ncbi.nlm.nih.gov/pubmed/?term=Schalick%20W), [Singh T](https://www.ncbi.nlm.nih.gov/pubmed/?term=Singh%20T), [Wright J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Wright%20J).

[**Author information**](https://www.ncbi.nlm.nih.gov/pubmed)

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**Abstract**

**BACKGROUND:**

CT imaging of head-injured children has risks of radiation-induced malignancy. Our aim was to identify children at very low risk of clinically-important traumatic brain injuries (ciTBI) for whom CT might be unnecessary.

**METHODS:**

We enrolled patients younger than 18 years presenting within 24 h of head trauma with Glasgow Coma Scale scores of 14-15 in 25 North American emergency departments. We derived and validated age-specific prediction rules for ciTBI (death from traumatic brain injury, neurosurgery, intubation >24 h, or hospital admission >or=2 nights).

**FINDINGS:**

We enrolled and analysed 42 412 children (derivation and validation populations: 8502 and 2216 younger than 2 years, and 25 283 and 6411 aged 2 years and older). We obtained CT scans on 14 969 (35.3%); ciTBIs occurred in 376 (0.9%), and 60 (0.1%) underwent neurosurgery. In the validation population, the prediction rule for children younger than 2 years (normal mental status, no scalp haematoma except frontal, no loss of consciousness or loss of consciousness for less than 5 s, non-severe injury mechanism, no palpable skull fracture, and acting normally according to the parents) had a negative predictive value for ciTBI of 1176/1176 (100.0%, 95% CI 99.7-100 0) and sensitivity of 25/25 (100%, 86.3-100.0). 167 (24.1%) of 694 CT-imaged patients younger than 2 years were in this low-risk group. The prediction rule for children aged 2 years and older (normal mental status, no loss of consciousness, no vomiting, non-severe injury mechanism, no signs of basilar skull fracture, and no severe headache) had a negative predictive value of 3798/3800 (99.95%, 99.81-99.99) and sensitivity of 61/63 (96.8%, 89.0-99.6). 446 (20.1%) of 2223 CT-imaged patients aged 2 years and older were in this low-risk group. Neither rule missed neurosurgery in validation populations.

**INTERPRETATION:**

These validated prediction rules identified children at very low risk of ciTBIs for whom CT can routinely be obviated.

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**Comment in**

* [Identification of children with low-risk brain injuries.](https://www.ncbi.nlm.nih.gov/pubmed/20109919) [Lancet. 2010]
* [Clinically important head injuries after head trauma in children.](https://www.ncbi.nlm.nih.gov/pubmed/19758693) [Lancet. 2009]
* [When is it safe to forego a CT in kids with head trauma?](https://www.ncbi.nlm.nih.gov/pubmed/20230734) [J Fam Pract. 2010]
* [Decision rules can identify children at very low risk of clinically important traumatic brain injury.](https://www.ncbi.nlm.nih.gov/pubmed/20176197) [J Pediatr. 2010]
* [Prediction of Persistent Postconcussion Symptoms in Youth Using a Neuroimaging Decision Rule.](https://www.ncbi.nlm.nih.gov/pubmed/26523635) [Acad Pediatr. 2016]

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