

**TEXAS CHILDREN'S HOSPITAL**  
**EVIDENCE-BASED OUTCOMES CENTER**

Closed Head Injuries Presenting to the Emergency Center (EC) within 24 Hours  
Evidence Summary

**Inclusion Criteria**

- Patients < 18 years of age
- Closed head injury within the last 24 hours
- Clinically stable

**Exclusion Criteria**

- Patients > 18 years of age
- Open head injury
- Clinically unstable
- Currently on anticoagulant therapy
- Presence of VP shunt
- Suspected Non-Accidental Trauma (NAT) <12 months of age
- Pre-existing neurological disorders
- History of brain tumor
- History of brain trauma

**Background**

Head trauma in children is a common cause for presentation to the emergency center (EC). It has been reported that almost half a million (473,947) emergency department visits for traumatic brain injuries (TBI) are made annually by children aged 14 years and younger. <sup>(3)</sup> Most closed head injuries in children are minor and not associated with serious or long term complications. Less than 5% of children presenting to the EC with minor head injury have a clinically important traumatic brain injury (ciTBI) and of those, less than 1% require neurosurgical intervention. <sup>(4)</sup> However, children presenting with a ciTBI require timely intervention and should be quickly identified. <sup>(4)</sup>

Currently, computed tomography (CT) is the diagnostic gold standard for identifying the presence of a ciTBI. Unfortunately, despite rapid and definitive results, CT imaging is not always appropriate. <sup>(2, 5)</sup> Not only is CT imaging resource intensive but it also comes with the risk of radiation exposure and radiation-induced malignancies. One study found that in patients less than 10 years of age, one additional brain tumor case per 10,000 head CT scans is estimated to occur. <sup>(6)</sup> This same study found that cumulative ionizing radiation doses from 2-3 head CTs (~60mGy) could increase the risk for brain tumors by up to three times, in children less than 15 years of age. <sup>(6)</sup> Therefore, radiation doses from CT scans should be kept to a minimum unless the clinical benefits of CT imaging outweigh the risks.

To better aid providers in deciding which patients are at very low risk for a ciTBI and should not receive a CT scan, clinical decision rules (CDRs) can be useful. The Pediatric Emergency Care Applied Research Network (PECARN) Pediatric Head Injury/Trauma Algorithm is a validated tool for identifying children at very low risk of ciTBI for whom CT might be unnecessary.

**Critically Analyze the Evidence**

The **GRADE criteria** were used to evaluate the quality of evidence presented in research articles reviewed during the development of this guideline. The table below defines how the quality of evidence is rated and how a strong versus a weak recommendation is established.

Recommendation	
<b>STRONG</b>	Desirable effects clearly outweigh undesirable effects or vice versa
<b>WEAK</b>	Desirable effects closely balanced with undesirable effects
Quality	Type of Evidence
<b>High</b>	Consistent evidence from well-performed RCTs or exceptionally strong evidence from unbiased observational studies
<b>Moderate</b>	Evidence from RCTs with important limitations (e.g., inconsistent results, methodological flaws, indirect evidence, or imprecise results) or unusually strong evidence from unbiased observational studies
<b>Low</b>	Evidence for at least 1 critical outcome from observational studies, from RCTs with serious flaws or indirect evidence
<b>Very Low</b>	Evidence for at least 1 critical outcome from unsystematic clinical observations or very indirect evidence

**PICO Question 1:** In patients <18 years of age, who present to the Emergency Center (EC) within 24 hours of a closed head injury, is the Pediatric Emergency Care Applied Research Network (PECARN) Pediatric Head Injury/Trauma Algorithm suitable for determining the necessity for CT imaging?

**Recommendation(s):** **Strong recommendation** with **low quality evidence** to utilize the PECARN Pediatric Head Injury/Trauma Algorithm to determine the necessity for CT imaging for patients <18 years of age who present to the EC within 24 hours of a closed head injury. (1, 2, 4, 5, 7)

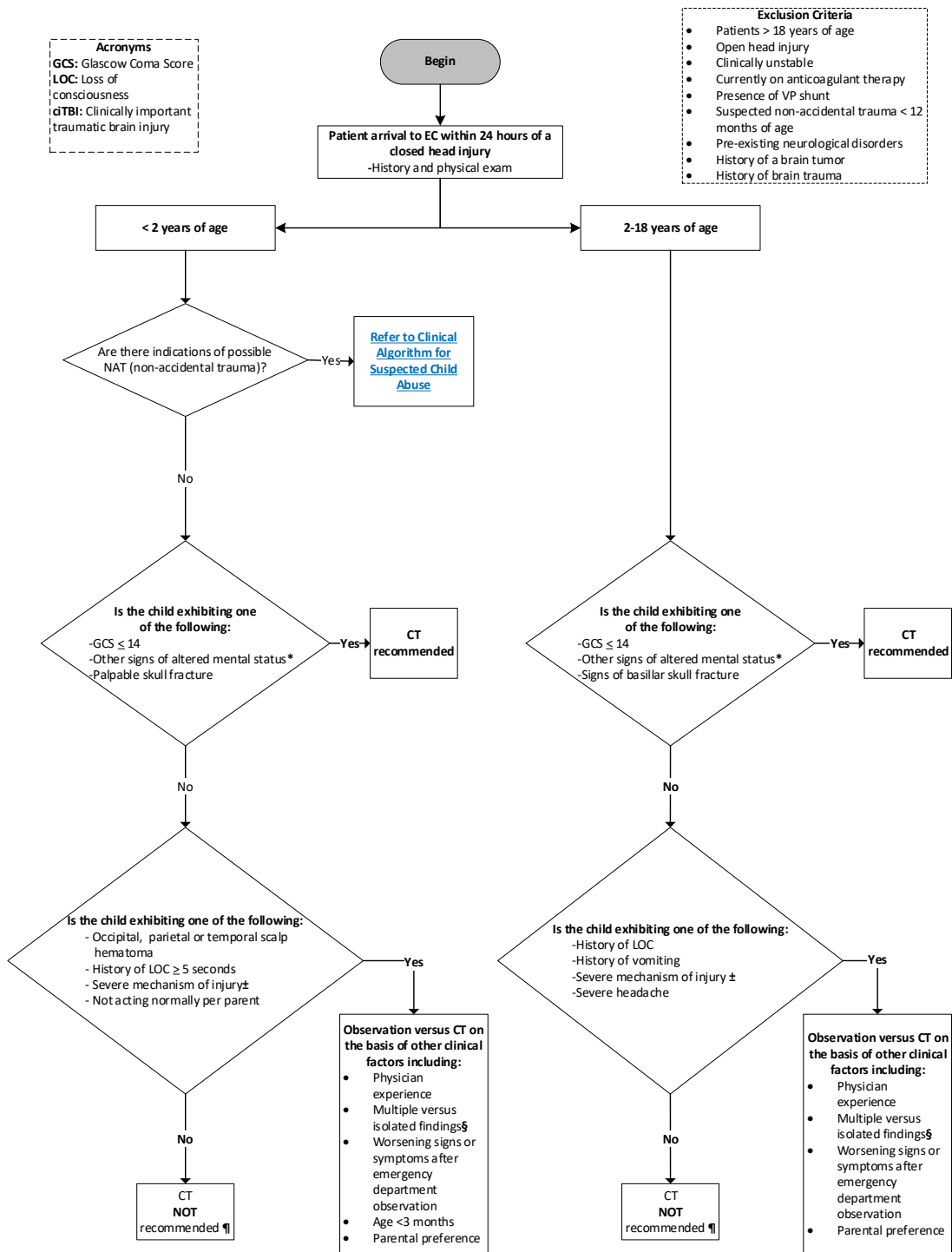
**Remarks:** CT imaging should be reserved to those at high risk for a ciTBI in order to reduce the risk of ionizing radiation and related malignancies in a majority of children with closed head injuries.

#### **Critical Points of Evidence**

##### ***Evidence Supports***

- The PECARN Head Injury/Trauma Algorithm identified children at very low risk for a ciTBI accurately. (7) –Strong recommendation, very low quality evidence
- The utilization of the PECARN Pediatric Head Injury/Trauma Algorithm to determine the necessity for CT imaging for patients <18 years of age who present to the EC within 24 hours of a closed head injury. (1, 2, 4, 5, 6)

# TCH Evidence-Based Outcomes Center Clinical Algorithm for Closed Head Injuries Presenting to the Emergency Center (EC) within 24 Hours



\* "Other signs of altered mental status: agitation, somnolence, repetitive questioning, or slow response to verbal communication."  
 ‡ "Severe mechanism of injury: motor vehicle crash with patient ejection, death of another passenger, or rollover; pedestrian or bicyclist without helmet struck by a motorized vehicle; falls of more than 3 ft (0.9 m) for children <2 years or more than 5 ft (1.5 m) for children aged 2-18 years; or head struck by a high-impact object."  
 § "Patients with certain isolated findings (i.e. with no other findings suggestive of traumatic brain injury), such as isolated LOC, isolated headache, isolated vomiting, and certain types of isolated scalp hematomas in infants older than 3 months, have a risk of cTBI substantially lower than 1%."  
 ¶ "Risk of cTBI is exceedingly low, generally lower than risk of CT-induced malignancies. Therefore, CT scans are not indicated for most patients in this group."

Algorithm and supporting statements adapted from the PECARN Pediatric Head Injury/Trauma Algorithm:  
 Kuppemmann, N., Holmes, J. F., Dayan, P. S., Hoyle, J. D., Jr., Atabaki, S. M., Holubkov, R., . . . Wootton-Gorges, S. L. (2009). Identification of children at very low risk of clinically-important brain injuries after head trauma: prospective cohort study. *Lancet*, 374(9696), 1160-1170. doi: 10.1016/s0140-6736(09)61558-0

## References

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2. Easter, J. S., Bakes, K., Dhaliwal, J., Miller, M., Caruso, E., & Haukoos, J. S. (2014). Comparison of PECARN, CATCH, and CHALICE rules for children with minor head injury: a prospective cohort study. *Ann Emerg Med*, *64*(2), 145-152, 152 e141-145. doi: 10.1016/j.annemergmed.2014.01.030
3. Faul, M., Xu, L., Wald, M.M., Coronado, V.G. Traumatic Brain Injury in the United States: Emergency Department Visits, hospitalizations and Deaths 2002-2006. Atlanta, GA; Centers for Disease Control and Prevention, National Center for Injury Prevention and Control, 2010.
4. Kuppermann, N., Holmes, J. F., Dayan, P. S., Hoyle, J. D., Jr., Atabaki, S. M., Holubkov, R., . . . Wootton-Gorges, S. L. (2009). Identification of children at very low risk of clinically-important brain injuries after head trauma: a prospective cohort study. *Lancet*, *374*(9696), 1160-1170. doi: 10.1016/s0140-6736(09)61558-0
5. Lorton, F., Poullaouec, C., Legallais, E., Simon-Pimmel, J., Chene, M. A., Leroy, H., . . . Gras-Le Guen, C. (2016). Validation of the PECARN clinical decision rule for children with minor head trauma: a French multicenter prospective study. *Scand J Trauma Resusc Emerg Med*, *24*, 98. doi: 10.1186/s13049-016-0287-3
6. Pearce MS, Salotti JA, Little MP, et al. Radiation exposure from CT scans in childhood and subsequent risk of leukaemia brain tumours: a retrospective cohort study. *Lancet*. 2012; *380*(9840):499-505.
7. Schonfeld, D., Bressan, S., Da Dalt, L., Henien, M. N., Winnett, J. A., & Nigrovic, L. E. (2014). Pediatric Emergency Care Applied Research Network head injury clinical prediction rules are reliable in practice. *Arch Dis Child*, *99*(5), 427-431. doi: 10.1136/archdischild-2013-305004
8. Thiam, D. W., Yap, S. H., & Chong, S. L. (2015). Clinical Decision Rules for Paediatric Minor Head Injury: Are CT Scans a Necessary Evil? *Ann Acad Med Singapore*, *44*(9), 335-341.

**Clinical Standards Preparation**

This clinical standard was prepared by the Evidence-Based Outcomes Center (EBOC) team in collaboration with content experts at Texas Children’s Hospital. Development of this clinical standard supports the TCH Quality and Patient Safety Program initiative to promote clinical standards and outcomes that build a culture of quality and safety within the organization.

**Closed Head Injuries in the EC Content Expert Team**

Binita Patel MD- Chief Medical Quality Officer  
 Julie McManemy MD-Emergency Medicine  
 Daniel Rubalcava MD-Emergency Medicine  
 William Whitehead MD, MPH- Neurosurgery  
 Marcia Kukreja MD-Radiology

**EBOC Team**

No relevant financial or intellectual conflicts to report.

**Development Process**

This clinical standard was developed using the process outlined in the EBOC Manual. The literature appraisal documents the following steps:

1. Review Preparation
  - PICO questions established
  - Evidence search confirmed with content experts
2. Review of Existing External Guidelines
  - Initial Assessment of Closed Head Injuries in the EC
3. Literature Review of Relevant Evidence
  - Searched: PubMed, Cochrane
4. Critically Analyze the Evidence
  - 5 nonrandomized studies
5. Summarize the Evidence
  - Materials used in the development of the clinical standard, literature appraisal, and any order sets are maintained in a Closed Head Injuries in the EC evidence-based review manual within EBOC.

**Evaluating the Quality of the Evidence**

Published clinical guidelines were evaluated for this review using the **AGREE II** criteria. The summary of these guidelines are included in the literature appraisal. AGREE II criteria evaluate Guideline Scope and Purpose, Stakeholder Involvement, Rigor of Development, Clarity and Presentation, Applicability, and Editorial Independence using a 4-point Likert scale. The higher the score, the more comprehensive the guideline.

This clinical standard specifically summarizes the evidence *in support of* or *against* specific interventions and identifies where evidence is *lacking/inconclusive*. The following categories describe how research findings provide support for treatment interventions.

**“Evidence Supports”** provides evidence to support an intervention

**“Evidence Against”** provides evidence against an intervention.

**“Evidence Lacking/Inconclusive”** indicates there is insufficient evidence to support or refute an intervention and no conclusion can be drawn *from the evidence*.

The **GRADE** criteria were utilized to evaluate the body of evidence used to make practice recommendations. The table below defines how the quality of the evidence is rated and how a strong versus weak recommendation is established. The literature appraisal reflects the critical points of evidence.

Recommendation	
<b>STRONG</b>	Desirable effects clearly outweigh undesirable effects or vice versa
<b>WEAK</b>	Desirable effects closely balanced with undesirable effects
Quality	Type of Evidence
<b>High</b>	Consistent evidence from well-performed RCTs or exceptionally strong evidence from unbiased observational studies
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<b>Very Low</b>	Evidence for at least 1 critical outcome from unsystematic clinical observations or very indirect evidence

**Recommendations**

Practice recommendations were directed by the existing evidence and consensus amongst the content experts. Patient and family preferences were included when possible. The Content Expert Team and EBOC team remain aware of the controversies in the diagnosis/management of closed head injuries in the EC in children. When evidence is lacking, options in care are provided in the clinical standard and the accompanying order sets (if applicable).

**Approval Process**

Clinical standards are reviewed and approved by hospital committees as deemed appropriate for its intended use. Clinical standards are reviewed as necessary within EBOC at Texas Children’s Hospital. Content Expert Teams are involved with every review and update.

**Disclaimer**

Practice recommendations are based upon the evidence available at the time the clinical standard was developed. Clinical standards (guidelines, summaries, or pathways) do not set out the standard of care and are not intended to be used to dictate a course of care. Each physician/practitioner should use his or her independent judgment in the management of any specific patient and is responsible, in consultation with the patient and/or the patient’s family, to make the ultimate judgment regarding care.

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**Version History**

Date	Action	Comments
06/16/2011	Originally Completed	
12/12/2017	Updated	PICO question changed, new recommendation made, new algorithm created.
Apr 2022	Reaffirmed	Reaffirmed with no new evidence search