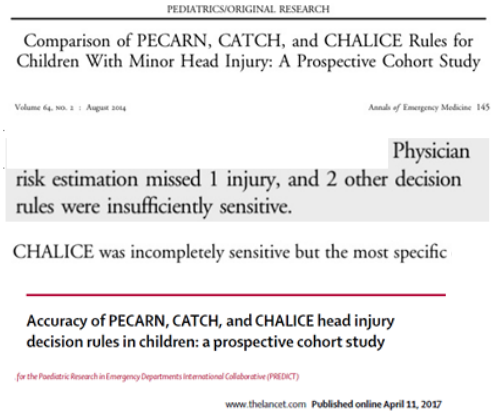
Clinical update no. 531
20 February 2019

Practical decision instruments to guide CT imaging for children with head trauma have been difficult to develop, and have not been shown to be better than clinical evaluation. Of concern is that using them would lead to more CT imaging of children, with more missed diagnosis of clinically important brain injury.

The CHALICE decision instrument has never been validated. It is the worst performing with the highest rate of missed injury.



PEDIATRICS/ORIGINAL RESEARCH

Comparison of PECARN, CATCH, and CHALICE Rules for Children With Minor Head Injury: A Prospective Cohort Study

Volume 64, no. 2 : August 2014 Annals of Emergency Medicine 145

Physician risk estimation missed 1 injury, and 2 other decision rules were insufficiently sensitive.

CHALICE was incompletely sensitive but the most specific

Accuracy of PECARN, CATCH, and CHALICE head injury decision rules in children: a prospective cohort study

for the Paediatric Research in Emergency Departments International Collaborative (PREDICT)

www.thelancet.com Published online April 11, 2017

The sensitivity of CHALICE was 92% for clinically important brain injury, i.e. missed 8% (12 of 160 injuries were –ve on the criteria); 90% for traumatic injury on CT (24 of 251 injuries had –ve CHALICE criteria). 2 of 24 requiring neurosurgery were missed.

The features present in patients with missed injuries according to CHALICE were falls less than 3 m, fewer than three vomiting episodes, and change in mental status besides abnormal drowsiness.

Paediatric head imaging decisions are not child's play

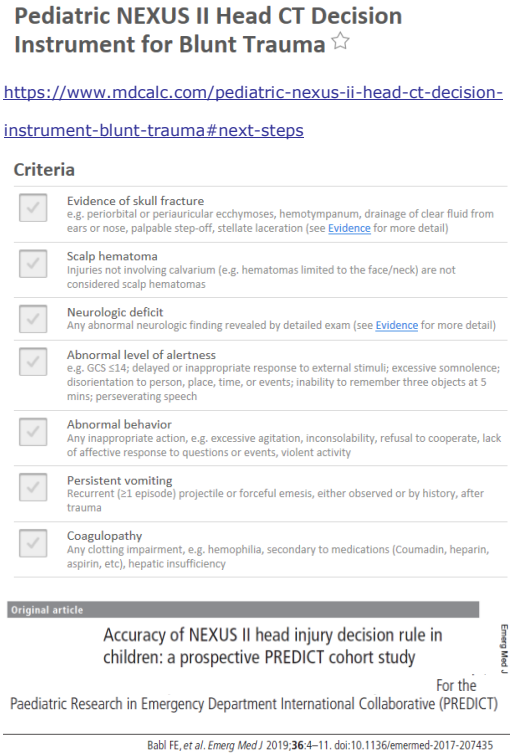
www.thelancet.com Published online April 11, 2017

The number of missed injuries using CHALICE is unacceptably high and restricts its clinical utility.

As well, using the CHALICE criteria would double the rate of CT imaging from 10% done in practice to 22% if criteria were followed.

The PECARN guide has better sensitivity but entails a high rate of CT imaging, although it does allow for clinical judgement and a period of observation. A recent study reported a trivial reduction in CT ordering when used, from 24.2 to 21.6% in a low risk group where the underlying risk of clinically important brain injury injury was about 1 in 200 (0.2 - 0.7%), *Ann Emerg Med* 2018 Dec, in press.

An Australian study evaluated the NEXUS II decision instrument in children. The 7 criteria, as defined, are evidence of skull #, scalp haematoma, neurological deficit, abnormal level of alertness, abnormal behaviour, persistent vomiting and coagulopathy.



Pediatric NEXUS II Head CT Decision Instrument for Blunt Trauma ☆

https://www.mdcalc.com/pediatric-nexus-ii-head-ct-decision-instrument-blunt-trauma#next-steps

Criteria

- Evidence of skull fracture
  e.g. periorbital or periauricular ecchymoses, hemotympanum, drainage of clear fluid from ears or nose, palpable step-off, stellate laceration (see Evidence for more detail)
- Scalp hematoma
  Injuries not involving calvarium (e.g. hematomas limited to the face/neck) are not considered scalp hematomas
- Neurologic deficit
  Any abnormal neurologic finding revealed by detailed exam (see Evidence for more detail)
- Abnormal level of alertness
  e.g. GCS ≤14; delayed or inappropriate response to external stimuli; excessive somnolence; disorientation to person, place, time, or events; inability to remember three objects at 5 mins; perseverating speech
- Abnormal behavior
  Any inappropriate action, e.g. excessive agitation, inconsolability, refusal to cooperate, lack of affective response to questions or events, violent activity
- Persistent vomiting
  Recurrent (≥1 episode) projectile or forceful emesis, either observed or by history, after trauma
- Coagulopathy
  Any clotting impairment, e.g. hemophilia, secondary to medications (Coumadin, heparin, aspirin, etc), hepatic insufficiency

Original article

Accuracy of NEXUS II head injury decision rule in children: a prospective PREDICT cohort study

For the Paediatric Research in Emergency Department International Collaborative (PREDICT)

Emerg Med J

Babl FE, *et al*. *Emerg Med J* 2019;**36**:4–11. doi:10.1136/emermed-2017-207435

A prospective observational study of patients <18 years with head trauma assessing the accuracy of the NEXUS II rule to detect clinically important intracranial injury (ICI).

N = 20 137, median age 4.2yr (26% <3yr).

CTs were obtained for 9.8%, of whom 19.2% had ICI. 19.6% with ICI had neurosurgery; there were 10 deaths.

Sensitivity for ICI based on the NEXUS II criteria was 99.0 % (95% CI 97.3% - 99.7%) and specificity was 47.2% (95% CI 46.5% - 47.9%) for the total cohort.

Of the 18 022 children not having CT, 49.4% had at least one NEXUS II risk criterion.

Sensitivity for ICI by the clinicians without the rule was 100.0% and specificity 92.0%.

Conclusions NEXUS II had high sensitivity. However, half of unimaged patients were positive for NEXUS II. Using NEXUS II criteria may lead to increased CT use in a setting with high clinician accuracy.

Table 3 Frequency and count of individual risk criteria

	% with ICI meeting criteria	
	<3yr	3-18yr
Criterion	**%**	**%**
N		
Risk criteria count		
0	0.0	1.6
1	7.0	17.7
2	31.0	23.8
3	34.1	29.4
4	19.4	19.8
5	7.0	6.9
6	1.6	0.8
7	0.0	0.0

Note: low % in those with multiple risk factors represent a low overall number with multiple risks. Of relevance is the % of ICI with 0 or 1 risk factors. A greater % had 2 or more.

% of ICI with specified risk factor present

	<3yr	3-18yr
Risk criteria		
1. Evidence of skull fracture	72.1	56.8
Missing	0.0	0.3
2. Scalp haematoma	70.5	57.6
Missing	0.0	0.0
3. Neurological deficits	12.4	10.9
Missing	0.0	0.0
4. Altered levels of alertness	51.2	62.3
Missing	0.0	0.0
5. Abnormal behaviour	58.1	57.3
Missing	0.0	0.0
6. Persistent vomiting	17.1	26.0
Missing	0.0	0.0
7. Coagulopathy	1.6	2.9
Missing	0.0	0.0

Risk factors more commonly present with ICI were evidence of skull #, scalp haematoma, altered alertness and abnormal behaviour.

The most frequent ICI were skull #, and subdural/extradural haemorrhage and contusions; the most frequent intervention was ICP monitoring and craniotomy.

Missed injury using NEXUS II criteria

Four patients met no NEXUS II criteria but had CT findings of ICI. They were admitted but none required neurosurgery (4yr M with fall from scooter/no helmet (pneumocephalus/ basal skull #); 5yr M fall >3m (ICH/ contusion, #); 6yr F fall 1.8m from stairs (ICH/contusion, #); 15yr M struck by person (ICH/contusion).

Anticipated increase in CT scanning if NEXUS II criteria were followed:

51.7% would require CT based on NEXUS II criteria compared with 10.4% who actually had CT, with no increase in detection of ICI or need for intervention. Clinicians did not miss a single patient with ICI.

Previous studies have shown that isolated scalp haematoma and vomiting do not predict an increased risk of ICH (from PECARN data).

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

Volume 63, no. 6 : June 2014 Annals of Emergency Medicine 657

In 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,

Risk of Traumatic Brain Injuries in Children Younger than 24 Months With Isolated Scalp Hematomas

Volume 64, no. 2 : August 2014 Annals of Emergency Medicine 153

isolated scalp hematomas (ie, without other symptoms or signs of brain injury) are common, yet were very uncommonly associated with traumatic brain injuries requiring an acute medical intervention, particularly neurosurgery.

Awareness of the odds ratio for ICI of individual risk factors in isolation may mitigate against the unnecessary imaging that their presence might otherwise mandate if clinical decision rules are to be introduced in practice.

As noted by the authors:

> Only CDRs that have been derived according to rigorous methodological standards and are externally validated should be implemented in routine clinical practice.[4]

These updates are a review of current literature at the time of writing. They do not replace local treatment protocols and policy. Treating doctors are individually responsible for following standard of care.