

## Managing isolated head trauma in young children

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See also page 1202 and [www.cmaj.ca/lookup/doi/10.1503/cmaj.150540](http://www.cmaj.ca/lookup/doi/10.1503/cmaj.150540)

In a linked paper, Gravel and colleagues have developed and validated a clinical decision rule for the use of radiologic evaluation to identify skull fracture in young children following an isolated head trauma.<sup>1</sup> Head trauma in children is common, leading to more than 20 000 emergency department visits each year in Canada and more than 470 000 in the United States.<sup>2</sup> Although most head injuries are benign, important complications include skull fracture and traumatic brain injury.<sup>3</sup> The presence of a skull fracture is associated with a high risk of intracranial hematoma and the development of leptomeningeal cysts.<sup>4</sup>

The decision to order head imaging in a child with an isolated minor head trauma is a diagnostic dilemma: injuries are common, yet few result in a clinically important injury. Computed tomography (CT) scans are the gold standard to identify injuries in need of neurosurgical intervention, yet they carry a small, but significant increased risk of cancer.<sup>5</sup> Fortunately, clinical decision rules have been developed to identify which children require a CT scan. The US-based Pediatric Emergency Care Applied Research Network (PECARN) rule identifies features that exclude the need to image.<sup>6</sup> The Pediatric Emergency Research of Canada (PERC) Network developed the CATCH rule to decide which children require a CT scan.<sup>7</sup>

Clinical uncertainty remains for children with minor head injury who fail to meet the criteria for CT imaging but have a potentially important risk factor, such as brief loss of consciousness or a scalp hematoma. Between 29% and 33% of children fall into this category, and the decision to observe or obtain a CT scan is left to the clinician.<sup>6</sup> This dilemma is particularly salient in children less than two years old, because they cannot verbalize neurologic symptoms and a CT scan would require sedation.<sup>8</sup>

Gravel and colleagues' study helps to resolve this uncertainty.<sup>1</sup> Between 2011 and 2014, 1667 children aged less than two years were enrolled within 24 hours after their head injury: 811 in the derivation cohort and 856 in the validation cohort. Children were not eligible if they met criteria for a CT scan (i.e., Glasgow Coma Scale score < 14 or

high risk of mild traumatic brain injury according to the PECARN rule), the clinician suspected child abuse or prior imaging had been obtained. Follow-up by telephone was conducted four weeks later for children who did not undergo radiologic evaluation (97% follow-up).

The overall incidence of skull fracture was 5.6%. Of the potential risk factors, two were found to be significant: parietal or occipital hematoma and age less than two months. Importantly, the clinical decision rule performed similarly in both the derivation (sensitivity 94%, specificity 86%) and validation (sensitivity 89%, specificity 87%) cohorts. The rule has important implications for the use of health care resources: application of the algorithm would have reduced the number of radiographs ordered by 60%, from 366 to 148.

The concern with any clinical prediction rule is the characteristics of patients missed. In the validation cohort, 5 of the 44 skull fractures were missed. Therefore, among children between 2 and 24 months of age without parietal or occipital swelling, the risk of skull fracture is 1 in 142 (0.7%). Of note, four missed fractures were in children less than four months of age. Extending the age group by two months would mean that only one fracture would have been missed in 663 children (0.2%), but any changes to the rule would need prospective validation.

This is the first published clinical decision rule that outlines the appropriate use of radiographs to identify skull fractures in light of the widespread adoption of the PECARN and CATCH rules. The American Academy of Pediatrics suggests obtaining a skull radiograph in the presence of certain high-risk factors,<sup>4</sup> and the Canadian Paediatric

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### KEY POINTS

- Head injuries in children are common and can lead to important complications such as skull fracture and traumatic brain injury.
- The role of skull radiography in children less than two years of age with isolated mild head trauma is unclear and varies according to published guidelines.
- The development and validation of a new clinical decision rule found that children less than two months and children with parietal or occipital hematomas are at high risk of skull fracture.

Society recommends radiologic evaluation in children less than two years of age with a large, boggy hematoma.<sup>2</sup> However, both guidelines leave considerable room for clinical judgment around the use of radiography. Furthermore, there may be a bias against the use of radiographs. Some clinicians want to know what is happening inside the skull rather than simply identifying the presence or absence of skull fracture. Although the PECARN study showed a low risk of sequelae in children with a linear skull fracture,<sup>9</sup> children with evidence of a skull fracture should be followed up closely for potential complications,<sup>2</sup> and further imaging may be warranted.

With Gravel and colleagues' rule, the decision to obtain a skull radiograph will be easy when risk factors are present. Unfortunately, these risk factors occur in less than one-fifth of children. In most cases, clinicians must exercise professional judgment to determine if radiologic evaluation is warranted, but they can rest assured that the likelihood of skull fracture is well below 1%.<sup>1</sup> The low prevalence of clinically significant injuries in young children is consistent with a secondary analysis of PECARN data.<sup>10</sup> When no imaging is ordered, precise discharge instructions are paramount. Clinicians should clearly explain to families what symptoms to look for and when to seek medical care and discuss injury prevention strategies.<sup>2</sup> Although excluded from the study, non-accidental injury should always be considered.

It is important to keep in mind that all of the emergency departments participating in Gravel and colleagues' study were in tertiary care centres. Although it is tempting to generalize the clinical decision rule to emergency departments in community hospitals and to primary care settings, caution is warranted, since the pre-test probabilities of skull fracture are likely different. Implementation studies are needed to assess performance in these settings.

The model outlined by the authors is useful for researchers involved in the development of decision rules. Researchers should consider building algorithms that incorporate routinely used rules, rather than trying to marginally improve on existing ones.

Gravel and colleagues provide an excellent example of improving the evidence base in child health while reducing clinical uncertainty.<sup>1</sup> The

prospective observational study asks an important clinical question and elegantly incorporates a previously validated and extensively used clinical decision rule. The authors provide front-line clinicians with objective decision-making criteria, more helpful than "observation versus CT."<sup>6</sup> But perhaps most important, the rule is simple: in children less than two years old with a minor head injury who do not meet the criteria for a CT scan, perform a skull radiograph if they are less than two months old or they have parietal or occipital swelling. If only all clinical decision rules could be this simple.

## References

1. Gravel J, Guoin S, Chalut D, et al. Derivation and validation of a clinical decision rule to identify young children with skull fracture following isolated head trauma. *CMAJ* 2015;187:1202-8.
2. Farrell CA; Canadian Paediatric Society, Acute Care Committee. Management of the paediatric patient with acute head trauma. *Paediatr Child Health (Oxford)* 2013;18:253-8.
3. Da Dalt L, Marchi AG, Laudizi L, et al. Predictors of intracranial injuries in children after blunt head trauma. *Eur J Pediatr* 2006;165:142-8.
4. Schutzman SA, Barnes P, Duhaime AC, et al. Evaluation and management of children younger than two years old with apparently minor head trauma: proposed guidelines. *Pediatrics* 2001;107:983-93.
5. Mathews JD, Forsythe AV, Brady Z, et al. Cancer risk in 680 000 people exposed to computed tomography scans in childhood or adolescence: data linkage study of 11 million Australians. *BMJ* 2013;346:f2360.
6. Kuppermann N, Holmes JF, Dayan PS, et al.; Pediatric Emergency Care Applied Research Network (PECARN). Identification of children at very low risk of clinically-important brain injuries after head trauma: a prospective cohort study. *Lancet* 2009;374:1160-70.
7. Osmond MH, Klassen TP, Wells GA, et al.; Pediatric Emergency Research Canada (PERC) Head Injury Study Group. CATCH: a clinical decision rule for the use of computed tomography in children with minor head injury. *CMAJ* 2010;182:341-8.
8. Hoyle JD Jr, Callahan JM, Badawy M, et al.; Traumatic Brain Injury Study Group for the Pediatric Emergency Care Applied Research Network (PECARN). Pharmacological sedation for cranial computed tomography in children after minor blunt head trauma. *Pediatr Emerg Care* 2014;30:1-7.
9. Powell EC, Atabaki SM, Wootton-Gorges S, et al. Isolated linear skull fractures in children with blunt head trauma. *Pediatrics* 2015;135:e851-7.
10. Dayan PS, Holmes JF, Schutzman S, et al.; Traumatic Brain Injury Study Group of the Pediatric Emergency Care Applied Research Network (PECARN). Risk of traumatic brain injuries in children younger than 24 months with isolated scalp hematomas. *Ann Emerg Med* 2014;64:153-62.

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