Journal Club Synopsis

February 12, 2013
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What is the appropriate use of head CT in minor pediatric head trauma?

Clinical Scenario:

You are working a busy shift in the ED at Children's, and when you pick up your next chart, you see that the patient is a 14 month old with a chief complaint of "head injury." You walk into the room and see a happy, well appearing 14 month old walking around the room and playing with toys. Mom tells you that the child was running and slipped, smashing her forehead against the corner of the coffee table. Mom saw the incident happen, and the child did not lose consciousness. She threw up once a few minutes after it happened, but has otherwise been behaving normally. On exam, she has age appropriate vital signs, a frontal hematoma with a 1 cm superficial laceration, otherwise no evidence of trauma and a normal neurological exam. Mom is freaking out and wants her child to get a CT scan "just to make sure that everything is OK." You're confused because you've worked with attendings who CT everyone, attendings who never CT anyone, and attendings that not only CT but order blood work too!

What evidence is there to support CT vs. no CT in this patient? If you chose not to CT, what can you tell Mom about the risks of missing a clinically significant traumatic brain injury? What physical exam findings would push you in the direction of a CT scan? Are there clinical decision rules that can be applied to this patient population?

Introduction:

Dorfman et al, Use of Medical Imaging Procedures with Ionizing Radiation in Children. Archives of Pediatric Adolescent Medicine 2011:165:458-464.

Nationally, the use of CT has rapidly increased owing to an increased availability of CT scanners and a lower threshold for ordering these studies in routine clinical practice. Rates of imaging in pediatrics are also increasing. In this study of 355,088 children, 42.5% received ionizing radiation during their visit to the emergency department. There are no good studies demonstrating the effects of ionizing radiation on pediatric patients or providing us with any kind of "safe number" in terms of dosage or number of CTs that can be performed before harmful effects are seen. We do know that infants and children are at higher risk for future malignant neoplasms compared with adults because developing tissue is more sensitive to the effects or radiation, and a longer expected life allows time for detrimental effects to emerge. Logically, it seems that development of prediction rules to limit head CTs in pediatric patients would be beneficial on a number of levels. It would certainly lower ER costs and would likely improve patient safety as well.

Article 1:

Kupperman et al. Identification of children at very low risk of clinically-important brain injuries after head trauma: a prospective cohort study. Lancet 2009;374:1160-70

Summary: This was a prospective cohort study that looked at over 40,000 children younger than 18 who presented within 24 hours of head trauma. For children younger than 2 years, the prediction rule for no CT head was: normal mental status, no scalp hematoma except for frontal, no loss of consciousness or loss of consciousness for less than 5 seconds, non-severe injury mechanism, no palpable skull fracture, and acting normally according to the parents. This had a negative prediction rule of 100% and a sensitivity of 100% for clinically important TBI. The prediction rule for children older than two was: normal mental status, no LOC, no vomiting, non-severe injury mechanism, no signs of basilar skull fracture and no severe headache. This had a negative predictive value of 99.95% (3798/3800) and a sensitivity of 61/63 (96.8%). In the validation group, use of these rules would have avoided 167 CT scans in the group younger than 2 years and 446 CT scans in the older group and would not have missed anyone who ended up needing a neurosurgical intervention.

Discussion: Overall, everyone felt that this was a well-designed study. It looked at a huge number of children and was the only study that I could find which separated out patients under two years old and came up with a separately derived prediction rule for them. I felt that this was one of the best things about the study; as we all know how difficult it is to do a neurological exam on a child less than two. We also liked that this study was first derived and then prospectively validated in a different population of patients. This was the only study that I was able to find which had been validated. We questioned the generalizability of this study, as it had taken place at a pediatric emergency department, but then others brought up the point that a pediatric ED probably already uses CT less frequently than a regular ED. Applying these decision rules to children in a regular ED may lower CT rates even more. One flaw of the study was that they did continue to include patients who they were unable to contact for follow up. They assumed that patients had no clinically important TBI if they had no repeat visits on chart review, even if the patients themselves were never contacted. Another weakness which was mentioned was the fact the study excluded children with “trivial injury mechanisms” such as ground-level falls or walking or running into stationary objects.

Article 2:

Osmond et al. CATCH: A clinical decision rule for the use of computed tomography in children with minor head injury. Canadian Medical Association Journal 2010;182(4). 341-347

Summary: This was a multicenter cohort study done in Canada. The purpose of the study was to develop a clinical decision rule for the use of CT in children with minor head injury. Children were enrolled if they presented with a GCS of 13-15, and had LOC, amnesia, disorientation, persistent vomiting, or irritability. Primary outcomes were the need for neurological intervention and the presence of brain injury on CT. 3866 patients were enrolled, CT showed evidence of injury in 4.1% and 0.6% needed neurosurgical intervention. The researchers derived 4 high risk factors for brain injury: failure to reach GCS of 15 within two hours, suspicion of open skull fracture, worsening headache and irritability. They

also derived three medium risk factors: large boggy hematoma, signs of basal skull fracture, and dangerous mechanism of injury. The high risk factors were 100% sensitive for detecting patients who would need neurosurgical intervention. The medium risk factors were 98.1% sensitive. If the high risk factors had been used, 30.2% of the patients would have needed a CT. If the medium risk factors had been used 52% of the patients would have needed a CT.

Discussion: This study was easy to understand. We liked that the decision rule was short and only included a few risk factors. However, there was concern because some of the risk factors are subjective. How do you really know if someone's headache is getting worse or if they are becoming more irritable? The study did show some interobserver differences in assessing people's risk factors. Using their four high-risk criteria, the CT rate would have decreased to 30%. However, the high-risk criteria seem fairly intuitively obvious and these were children that we all would have ordered a CT on anyways, regardless of this study. The medium risk factors concerned us enough that we would probably CT all of those people too. If the medium risk factors are used, the CT rate was 52%, and in the first paragraph of the article, it states that 53% of children in Canadian pediatric emergency departments already receive a CT head for minor head injury. With numbers like this, I question whether using these rules would actually decrease CT rates. We did like that the study excluded people who could not be contacted for follow up. Unlike the first study, this rule has not been prospectively validated.

Article 3:

Picking et al. Clinical decision rules for children with minor head injury: a systemic review. Archives of Disease in Childhood 2011;96:414-421.

Summary: This was a systemic review of clinical decision rules for children with minor head injury. The purpose of the study was to look at various clinical prediction rules and compare their diagnostic accuracy for the detection of intracranial injury and injury requiring neurosurgical intervention. 16 studies were included, representing 14 cohorts and 79,740 patients. The study felt that the PECARN rule was the best, in that it had the largest cohort, highest sensitivity (98%) and had been prospectively validated. The children's head injury algorithm for the prediction of important clinical events (CHALICE) rule, which is used in the UK, had the highest specificity at 86%.

Discussion: There was not a lot of discussion about this article itself. I included this study because it gave a broad overview of everything out there in terms of decision rules for minor pediatric head trauma. I liked how it was able to compare the studies to each other in terms of numbers needed to scan to catch one clinically significant intracranial injury. It did require some additional research, as each clinical prediction rule was not listed in the study.

Bottom Line: If our goal is to never miss an intracranial injury, PECARN appears to provide the best clinical decision rule for minor pediatric head trauma. However, to identify one clinically significant ICI, PECARN would scan 50 children and CHALICE would only scan 18. To identify one injury that needed neurosurgery, PECARN would scan over 200 children. There is an opening for additional research; and hopefully there will eventually be a clinical decision rule which is able to lower CT rates even more while

still catching almost all intracranial injuries. For now, we are left with several flawed decision rules and, of course, our clinical judgment.