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Improving Patient Selection for Pediatric Computed Tomographic Head Imaging

To the Editor:

The recent study by Dalziel et al[1] examining the cost-effectiveness of pediatric head injury decision rules failed to show cost benefit for any of the instruments when compared with usual care. Although these results are somewhat disappointing, they are not unexpected and reflect fundamental problems in the development of these tools.

The instruments that were studied were formulated with 2 goals in mind: first, to aid clinicians in identifying children who need imaging; and second, to help identify children who do not need imaging.[2,3] To achieve the first goal, the rules must assign high-risk status to essentially all children who have significant intracranial injuries. This is accomplished by ensuring that the rules have high sensitivity. In contrast, the second objective is accomplished by optimizing the specificity of the rule to enable it to identify as many children as possible for whom it is safe to omit imaging. Because missed injuries can lead to catastrophic outcomes, the rules are heavily weighted toward high sensitivity, even at the cost of decreased specificity. Although the logic behind this approach may appear reasonable, it fails to address the true clinical needs.

Large prospective studies demonstrate that significant head injuries are rare among patients discharged directly from the emergency department.[2-4] Using clinical judgment alone, physicians are already very good at identifying children with significant intracranial injuries. Their sensitivity in identifying children who need imaging equals or exceeds that of our best decision instruments. This ability was clearly evident before the development of decision instruments and persists to this day. The high sensitivity of clinical judgment provides little opportunity for decision instruments to improve injury detection and means we do not need them to help us decide which children need imaging. This nullifies the first goal in developing most decision instruments. The ability to identifying children who need imaging is superfluous. Clinical judgment already fulfills that need.

Clinical judgment provides another important service. It identifies the cohort of children who can truly benefit from application of a decision instrument. The high sensitivity of clinical judgment means that children judged as being at low risk have essentially no risk of significant intracranial injury, and no need for imaging. Application of a decision instrument to these low-risk children provides no benefit because the rule can only confirm low-risk status, or erroneously assign high-risk status, which can lead to a paradoxic increase in imaging and degradation of the value of the decision instrument.

Consequently, the target population for pediatric head imaging decision tools should be children who are classified as being at high risk on the basis of clinical judgment, and for whom computed tomographic (CT) imaging is being contemplated. Application of a decision instrument to this population may identify children who can safely be reclassified as being at low risk and excluded from imaging.

Under this paradigm, clinicians would complete clinical assessments of children who have sustained blunt head

injuries; those judged to be at low risk would receive no further evaluation and could be safely managed without imaging. Application of a decision instrument would be reserved for patients judged to be at risk on the basis of clinical impression, and for whom CT imaging is contemplated. Patients from among this cohort who are classified as being at low risk by a highly sensitive decision instrument could then be safely managed without imaging, whereas all other patients would undergo the imaging dictated by clinical judgment.

This approach differs from the approach embedded in most decision instruments, in which children with blunt head injury are assigned risk status by the decision instrument, and clinical judgment plays no role in risk assessment.

To date, the National Emergency X-Radiography Utilization Study (NEXUS) pediatric head CT imaging rule is the only decision instrument that has been developed and validated for use in children judged to be at high risk on the basis of clinical judgment.[5] This rule exhibits the high sensitivity needed to ensure that patients with significant intracranial injuries would not be reclassified as being at low risk while safely reclassifying nearly one third of patients as being at low risk and suitable for exclusion from CT imaging. Application of this rule could achieve the goals of imaging essentially all children with significant injuries while safely reducing overall imaging rates.

Our goal as scientists is not to promote a particular rule, but to identify optimal imaging strategies regardless of their origins. In this regard, it is unlikely that the NEXUS rule is the only one that can safely identify low-risk children from among those selected for CT imaging on the basis of clinical judgment. Modifications to the existing rules, including the Pediatric Emergency Care Applied Research Network rule, could provide similar benefit. This would require the investigators of other rules to shift their attention from the large population of all head-injured children and focus on children whose presentations were sufficiently concerning to merit CT imaging. Because this population contains essentially all children with significant injuries, the sensitivity of these rules should not change when the rule is applied to this select cohort. What will change is the functional specificity of the rules as they reclassify patients to low-risk status, making it safe to omit imaging.

As a consequence, we strongly urge the developers of pediatric head-imaging tools to perform secondary analyses of their data sets that focus only on children selected for imaging. The primary outcome from these analyses would be the specificity of the tool among this new target population and the proportion of children safely reclassified as being at low risk, and for whom imaging could safely be omitted. This in turn would enable us as scientists to identify the optimal imaging strategies that provide the greatest benefit to our patients.

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In reply:

We thank Dr. Mower for his response to our analysis of the cost-effectiveness of 3 clinical decision rules for neuroimaging in pediatric head injury in the Australasian Paediatric Head Injury Rules (APHRIST) study[1] comparing Children's Head Injury Algorithm for the Prediction of Important Clinical Events (CHALICE), Pediatric Emergency Care Applied Research Network (PECARN), and Canadian Assessment of Tomography for Childhood Head Injury (CATCH) with Australian and New Zealand usual care.[2]

Dr. Mower's concerns center on the fundamental premise and setup of the 3 clinical decision rules under investigation compared with the National Emergency X-Radiography Utilization Study II (NEXUS II) rule.[3] Specifically, argument is made that clinical judgment can remove low-risk populations before application of a clinical decision rule. However, clinical judgment is not universally applied, as evidenced by the 3-fold baseline difference in neuroimaging rates observed in the US hospitals participating in PECARN[4] compared with the Australian and New Zealand hospitals participating in APHIRST.[1] Furthermore, clinical judgment is variable with respect to