

# Clinical Decision Rules: A Starting Place in Medical Education, Not a Destination

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**A** new intern presents a case of head trauma to the attending in the emergency department. The intern says, “This is a case of a nearly asymptomatic 18-month-old toddler hit in the head by a baseball. As being hit by a baseball is not on the list of high-risk mechanisms of injury in the PECARN (Pediatric Emergency Care Applied Research Network) clinical decision rule, I consider this a low-risk injury. Neither a period of observation nor intracranial imaging are necessary.”

The increasing use of clinical decision rules (CDRs) provides opportunities while adding complexity for teaching, particularly for junior trainees. Currently, there is minimal literature on the role of CDRs in medical education. As recognizing their purpose and use is considered a core competency within evidence-based medicine,<sup>1</sup> educators should understand the potential educational limitations of an overreliance on CDRs.

CDRs are “tools that can help clinicians make diagnostic and therapeutic decisions at the bedside.”<sup>2</sup> The rule is derived from original research and incorporates 3 or more variables (predictors) from the history, physical examination, and/or simple tests.<sup>3</sup> CDRs often seek to answer a narrow question (risk of appendicitis, risk of streptococcal pharyngitis, etc) and thus differ from diagnostic criteria and clinical practice guidelines (CPGs). Diagnostic criteria are not a prediction rule. A particular diagnosis is confirmed, or at least highly suspected, when a patient meets established diagnostic criteria. CPGs may be viewed as more comprehensive documents created and vetted by multidisciplinary organizations.<sup>4</sup> CPGs typically consider broader clinical questions than CDRs and provide clinical recommendations. A subcategory of CPGs are clinical pathways (CPs), tools aiming “to translate clinical practice guideline recommendations into clinical processes of care within the unique culture and environment of the health care institution, thereby maximizing patient safety and clinical efficiency.”<sup>5</sup> Finally, the terms “clinical

decision rule” and “clinical prediction rule” are used synonymously in the literature. Box 1 provides a glossary for terms used.

Operationally, CDRs, CPGs, and CPs are often considered desirable as the use of rules “is rooted in the assumption that action in organizations... can be, to some degree, programmed.”<sup>6</sup> Educationally, CPGs and CPs are often considered a form of evidence summary within the evidence-based medicine literature.<sup>1,7,8</sup> CDRs do not fall within the scope of evidence summaries, but are tempting to share with residents because they offer a quick list of predictors important to consider in answering a clinical question. The novice resident who has no illness and/or management script for a clinical question can be rapidly oriented to a pathway to make a decision and can be rapidly armed with a starting place for future independent learning. A CDR may be attractive to a resident since available time is often cited as a reason why residents do not fully practice evidence-based medicine skills.<sup>9,10</sup> Educators who incorporate CDRs into their teaching should consider the list of potential limitations listed in BOX 2.

The annual publication rate of articles identified by the search term “clinical decision rule” has grown over the last 40 years. The authors identified 946 MEDLINE citations for the expanded term “clinical decision rule.” A review of all 946 abstracts identified the article by Chan et al<sup>11</sup> as the sole article published in the realm of medical education literature. Notably absent from the literature are thoughts on how the rise in usage of CDRs affects the training of residents on their journey to independent practice and, ideally, to expert clinicians. Educators should be aware of the growing bodies of literature on individual CDRs, the use of CPs, knowledge translation (with respect to the implementation of CDRs and CPs),<sup>12</sup> and on organizational behavior and the role of written rules.<sup>6</sup> As CDRs become ingrained in clinical practice, educators should consider how their use could alter the learning culture.

The questions listed in BOX 2 are generated from the opinion of the authors, all experienced educators. Considering the 6 questions individually will hopefully

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**BOX 1 Glossary of Terms**

**Clinical decision rule (CDR)**, also known as clinical prediction rule: A derived tool used to make clinical decisions.

**Clinical practice guideline (CPG)**: A comprehensive document created and vetted by multidisciplinary organizations.

**Clinical pathway (CP)**: A tool incorporating a CPG into a local clinical environment.

**Diagnostic criteria**: Universally accepted criteria that establish a particular diagnosis.

**Evidence summaries**: A secondary source of trustworthy information for use by the clinician.

**Predictor**: One of the variables (from history, physical examination, and/or simple diagnostic tests) incorporated into the CDR.

highlight potential limitations of CDR use by residents. When clinical examples may illustrate a point, reference will be made to the PECARN head injury rules for toddlers.<sup>13</sup>

### When Should the Rule Not Be Used?

The first question of CDR use considers the decision of when to use the rule. Each CDR centers on a clinical question and is designed to help clinicians make a distinction between 2 or more clinical conditions. For example, head injury imaging rules do not apply to the child with multiple injuries as other extracranial factors must be incorporated into decisions about head imaging.

### How Much Educational Effort Should Be Devoted to the Study of Individual Predictors?

Should trainees understand the role of the individual predictors in the CDR? For example, scalp hematoma is often a predictor in head injury rules applied to toddlers.<sup>13-15</sup> An intern may only be able to

**BOX 2 Questions to Consider When Incorporating Clinical Decision Rules Into Teaching**

1. When should the rule not be used?
2. How much educational effort should be devoted to the study of individual predictors?
3. What level of risk is considered acceptable, and does that level vary between rules?
4. How do we teach "physician experience"?
5. Does the act of presenting junior residents with a clinical decision rule distract from considering alternative diagnoses?
6. Does a learning environment heavily reliant upon decision rules negatively affect resident motivation?

manage the cognitive load of recognizing the hematoma and of recognizing there are multiple factors that need to be considered for head imaging. More experienced residents would likely benefit from studying the nuances of the controversy over which hematomas are independent risk factors for intracranial hemorrhage and which hematomas serve only as surrogate markers that a potentially medically significant head impact has occurred.<sup>16</sup> Tikkinen and Guyatt emphasize the current role of evidence-based medicine where understanding evidence summaries and their applicability are core skills of a medical curriculum.<sup>8</sup> This standard should be applied to CDRs that do not rise to the level of evidence summaries.

### What Level of Risk Is Considered Acceptable, and Does That Level Vary Between Rules?

Question 3 highlights the difference in acceptable risk between CDRs and the difficulty for learners and patients to understand and convey risk.<sup>17</sup> In consideration of the toddler presented at the beginning of this article, the intern referenced the PECARN head injury rule, where toddlers with a 1% risk of developing clinically significant intracranial hemorrhage after head injury are considered moderate risk.<sup>13</sup> Conversely, a 1% risk of major adverse cardiac event in the short term is considered a low risk in the HEART score among adults in the emergency department with chest pain.<sup>18</sup>

### How Do We Teach Physician Experience?

Question 4 acknowledges that "physician experience" may be a predictor in decision rules. How do we teach physician experience when, in the case of a moderate risk toddler with a head injury, a resident may finish training without seeing any children with moderate risk and an adverse event? Additionally, physician experience must be taught for the correct incorporation of predictors. In our case, the CDR states that if the "head is struck by a high-impact object" the child is in the moderate risk category. The clinical question in this case is, "Is a baseball a high-impact object?" Faculty must share the body of literature distinguishing injury risk<sup>19-24</sup> so that residents can be educated to become the expert clinicians who can incorporate physician experience into their use of CDRs.<sup>11</sup>

### Does the Act of Presenting Junior Residents With a Clinical Decision Rule Distract From Considering Alternative Diagnoses?

The final 2 questions consider the social environment of CDR use. Question 5 stresses the importance of preventing the residents from becoming so focused

on the CDR that they fail to consider alternative conditions. In the example of the head-injured toddler, it is important to remind the resident to consider whether the child is at risk of other injuries such as a cervical spine injury or nonaccidental trauma. This type of distracting behavior was observed by Swinglehurst et al<sup>25</sup> and led Thomas et al to comment, "...when teaching... we tend to focus our measurement on those things for which we have the tools to measure."<sup>26</sup>

### Does a Learning Environment Heavily Reliant Upon Decision Rules Negatively Affect Resident Motivation?

Question 6 is perhaps the most important of all. Does a clinical environment that values multiple CDRs inadvertently create an environment where the decision rule is a destination for learning and not a starting point? The literature based on self-regulated learning stresses that learners' final educational priorities and extent of skills obtained can be influenced by the environment in which they are immersed.<sup>27</sup> The idea of coregulation highlights the role others play in the self-regulated learning of a trainee.<sup>28</sup> Qualitative studies highlight the effect of expectations of and interactions with peers and clinical supervisors on residents' self-regulated learning.<sup>29</sup> Boor et al report that medical students lose motivation and limit their learning effort in unsupportive clinical situations.<sup>30</sup> There is a risk that if a resident is surrounded by peers all using the same decision rules, those decision rules become the "final destination" for self-regulated learning, even though the limited qualitative data suggests that expert clinicians often move beyond the CDRs in their own clinical practice.<sup>11</sup>

In summary, CDRs are increasing in popularity with no available literature on how to educate learners to incorporate these rules and how to provide development for supervising clinicians who use and teach these rules. If the goal of resident education is the acquisition of career-long skills in diagnostic<sup>31</sup> and management reasoning<sup>32</sup> where individual patient factors are considered, then educators must recognize and teach the limitations of CDRs. Clinical decision rules should be viewed as a starting place for resident education, not a destination.

### References

1. Albarqouni L, Hoffmann T, Straus S, et al. Core competencies in evidence-based practice for health professionals: consensus statement based on a systematic review and Delphi survey. *JAMA Netw Open*. 2018;1(2):e180281. doi:10.1001/jamanetworkopen.2018.0281
2. Stiell IG, Bennett C. Implementation of clinical decision rules in the emergency department. *Acad Emerg Med*. 2007;14(11):955-959. doi:10.1111/j.1553-2712.2007.tb02372.x
3. McGinn TG, Guyatt GH, Wyer PC, Naylor CD, Stiell G, Richardson WS. Users' guides to the medical literature XXII: how to use articles about clinical decision rules. *JAMA*. 2000;284(1):79-84. doi:10.1001/jama.284.1.79
4. Graham R, Mancher M, Wolman DM, Greenfield S, Steinberg E, eds. *Clinical Practice Guidelines We Can Trust*. National Academies Press; 2011. doi:10.17226/13058
5. Rotter T, de Jong RB, Lacko SE, Ronellenfitsch U, Kinsman L. Clinical pathways as a quality strategy. In: *Improving Healthcare Quality in Europe: Characteristics, Effectiveness and Implementation of Different Strategies [Internet]*. European Observatory on Health Systems and Policies; 2019. Accessed November 30, 2023. <https://www.ncbi.nlm.nih.gov/books/NBK549262/>
6. Zhu K, Schulz M. The dynamics of embedded rules: how do rule networks affect knowledge uptake of rules in healthcare? *J Manag Stud*. 2019;56(8):1683-1712. doi:10.1111/joms.12529
7. Garritty C, Stevens A, Hamel C, Golfam M, Hutton B, Wolfe D. Knowledge synthesis in evidence-based medicine. *Semin Nucl Med*. 2019;49(2):136-144. doi:10.1053/j.semnuclmed.2018.11.006
8. Tikkinen KAO, Guyatt GH. Understanding of research results, evidence summaries and their applicability—not critical appraisal—are core skills of medical curriculum. *BMJ Evid-Based Med*. 2021;26(5):231-233. doi:10.1136/bmjebm-2020-111542
9. Van Dijk N, Hooft L, Wieringa-de Waard M. What are the barriers to residents' practicing evidence-based medicine? A systematic review. *Acad Med*. 2010;85(7):1163-1170. doi:10.1097/ACM.0b013e3181d4152f
10. Green ML, Ruff TR. Why do residents fail to answer their clinical questions? A qualitative study of barriers to practicing evidence-based medicine. *Acad Med J Assoc Am Med Coll*. 2005;80(2):176-182. doi:10.1097/00001888-200502000-00016
11. Chan TM, Mercuri M, Turcotte M, Gardiner E, Sherbino J, de Wit K. Making decisions in the era of the clinical decision rule: how emergency physicians use clinical decision rules. *Acad Med*. 2020;95(8):1230. doi:10.1097/ACM.0000000000003098
12. Gaddis GM, Greenwald P, Huckson S. Toward improved implementation of evidence-based clinical algorithms: clinical practice guidelines, clinical decision rules, and clinical pathways. *Acad Emerg Med*. 2007;14(11):1015-1022. doi:10.1111/j.1553-2712.2007.tb02382.x

13. Kuppermann N, Holmes JF, Dayan PS, et al. Identification of children at very low risk of clinically-important brain injuries after head trauma: a prospective cohort study. *The Lancet*. 2009;374(9696): 1160-1170. doi:10.1016/S0140-6736(09)61558-0
14. Osmond MH, Klassen TP, Wells GA, et al. CATCH: a clinical decision rule for the use of computed tomography in children with minor head injury. *CMAJ Can Med Assoc J*. 2010;182(4):341-348. doi:10.1503/cmaj.091421
15. Dunning J, Daly JP, Lomas J, et al. Derivation of the children's head injury algorithm for the prediction of important clinical events decision rule for head injury in children. *Arch Dis Child*. 2006;91(11):885-891. doi:10.1136/adc.2005.083980
16. Greenes DS, Schutzman SA. Clinical indicators of intracranial injury in head-injured infants. *Pediatrics*. 1999;104(4):861-867. doi:10.1542/peds.104.4.861
17. Gigerenzer G, Gaissmaier W, Kurz-Milcke E, Schwartz LM, Woloshin S. Helping doctors and patients make sense of health statistics. *Psychol Sci Public Interest*. 2007;8(2):53-96. doi:10.1111/j.1539-6053.2008.00033.x
18. Backus BE, Six AJ, Kelder JC, et al. A prospective validation of the HEART score for chest pain patients at the emergency department. *Int J Cardiol*. 2013;168(3): 2153-2158. doi:10.1016/j.ijcard.2013.01.255
19. Smith GA, for the Committee on Injury V and Poison Prevention. Shopping cart-related injuries to children. *Pediatrics*. 2006;118(2):e540-e544. doi:10.1542/peds.2006-1216
20. De Roo AC, Chounthirath T, Smith GA. Television-related injuries to children in the United States, 1990-2011. *Pediatrics*. 2013;132(2):267-274. doi:10.1542/peds.2013-1086
21. Harris VA, Rochette LM, Smith GA. Pediatric injuries attributable to falls from windows in the United States in 1990-2008. *Pediatrics*. 2011;128(3):455-462. doi:10.1542/peds.2010-2687
22. Plunkett J. Fatal pediatric head injuries caused by short-distance falls. *Am J Forensic Med Pathol*. 2001;22(1):1.
23. Chiaviello CT, Christoph RA, Bond GR. Stairway-related injuries in children. *Pediatrics*. 1994;94(5): 679-681. doi:10.1542/peds.94.5.679
24. Joffe M, Ludwig S. Stairway injuries in children. *Pediatrics*. 1988;82(3):457-461. doi:10.1542/peds.82.3.457
25. Swinglehurst D, Greenhalgh T, Roberts C. Computer templates in chronic disease management: ethnographic case study in general practice. *BMJ Open*. 2012;2(6): e001754. doi:10.1136/bmjopen-2012-001754
26. Thomas A, Chin-Yee B, Mercuri M. Thirty years of teaching evidence-based medicine: have we been getting it all wrong? *Adv Health Sci Educ Theory Pract*. 2022;27(1):263-276. doi:10.1007/s10459-021-10077-4
27. van Houten-Schat MA, Berkhout JJ, van Dijk N, Endedijk MD, Jaarsma ADC, Diemers AD. Self-regulated learning in the clinical context: a systematic review. *Med Educ*. 2018;52(10):1008-1015. doi:10.1111/medu.13615
28. Rich JV. Proposing a model of co-regulated learning for graduate medical education. *Acad Med*. 2017;92(8): 1100. doi:10.1097/ACM.0000000000001583
29. Bransen D, Govaerts MJB, Sluijsmans DMA, Driessen EW. Beyond the self: the role of co-regulation in medical students' self-regulated learning. *Med Educ*. 2020;54(3):234-241. doi:10.1111/medu.14018
30. Boor K, Scheele F, van der Vleuten CPM, Teunissen PW, den Breejen EME, Scherpbier AJJA. How undergraduate clinical learning climates differ: a multi-method case study. *Med Educ*. 2008;42(10):1029-1036. doi:10.1111/j.1365-2923.2008.03149.x
31. Mamede S, Schmidt HG. Deliberate reflection and clinical reasoning: founding ideas and empirical findings. *Med Educ*. 2023;57(1):76-85. doi:10.1111/medu.14863
32. Abdoler EA, Parsons AS, Wijesekera TP. The future of teaching management reasoning: important questions and potential solutions. *Diagn Berl Ger*. 2023;10(1): 19-23. doi:10.1515/dx-2022-0048



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