Implementation of Clinical Decision Rules in the Emergency Department

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Abstract

Clinical decision rules (CDRs) are tools designed to help clinicians make bedside diagnostic and therapeutic decisions. The development of a CDR involves three stages: derivation, validation, and implementation. Several criteria need to be considered when designing and evaluating the results of an implementation trial. In this article, the authors review the results of implementation studies evaluating the effect of four CDRs: the Ottawa Ankle Rules, the Ottawa Knee Rule, the Canadian C-Spine Rule, and the Canadian CT Head Rule. Four implementation studies demonstrated that the implementation of CDRs in the emergency department (ED) safely reduced the use of radiography for ankle, knee, and cervical spine injuries. However, a recent trial failed to demonstrate an impact on computed tomography imaging rates. Well-developed and validated CDRs can be successfully implemented into practice, efficiently standardizing ED care. However, further research is needed to identify barriers to implementation in order to achieve improved uptake in the ED.

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Clinical decision rules (CDRs) are tools that help clinicians make diagnostic and therapeutic decisions at the bedside. They are derived from original research and incorporate three or more variables from the history, examination, or simple tests.[1–3] By standardizing the collection and interpretation of clinical data, CDRs attempt to reduce uncertainty in medical decision-making. Some examples of CDRs include guides for determining which patients with an ankle injury need x-rays, which patients need imaging to rule out a deep vein thrombosis, and which patients with pneumonia need admission.

Developing and testing a CDR involves three stages: creating or deriving the rule (derivation study); prospective assessment of the rule's accuracy, reliability, and potential impact (validation study); and assessment of the rule's impact on patient care (implementation study). While the impact of CDRs can be assessed by different methods, implementation studies provide the best evidence of their true effect on patient care.[4,5]

Several criteria are considered when designing or evaluating the results of an implementation trial for a new CDR. Implementation trials, best conducted using a randomized cluster or a controlled clinical trial design, have enhanced generalizability for results when conducted in as many different settings as possible.[3] The primary outcome measure of an implementation trial is normally the impact on process of care, for example, cesarean section rates, prescribing patterns, or use of diagnostic imaging. However, demonstrating the longer-term impact on health care outcomes (e.g., infant morbidity, cholesterol levels, costs) is also important. Two further criteria that need to be considered are accuracy and acceptability of the rule. It is important to ensure that the sensitivity and specificity of the rule are accurate and that there are few missed diagnoses. Last, acceptability of the rule needs to be considered from both the physicians' (comfort and compliance with use of the rule) and patients' (satisfaction with care) perspectives.

UPTAKE OF CDRs

For CDRs to have widespread effect on health care delivery, a plan for dissemination and implementation is essential. The gap between evidence and practice is one of the most consistent findings in health services research.[6] The traditional approach of passive diffusion, through publication of original research in medical journals or presentation at scientific meetings, is not targeted

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and has not been successful in significantly altering clinical practice. The more active process of dissemination targets a specific audience, tailoring the information to the group. Examples include meta-analyses, reviews, or practice guidelines that are distributed by targeted mailings, press, or visiting speakers. Implementation involves putting a guideline in place and is the most active process. It uses effective administrative and educational strategies, locally and persistently applied, to overcome barriers to the use of new information by practitioners.

There are a number of educational and noneducational factors affecting the adoption of new guidelines. Noneducational factors affecting adoption include attributes of the guideline itself: relative advantage (is new better than old?), compatibility (does it represent existing beliefs?), complexity (is it difficult to understand?), ability for trial (can the clinician try it out?), and observability (can one observe others using the guideline?). Noneducational factors also include characteristics of the health care professional (age, training, experience developing guidelines), the practice setting (system efficiency, habit and custom, beliefs of peers, social norms), incentives (legal and financial), regulations (accreditation, licensing bodies), and patient factors (individual demands, compliance, specific presentation).

Research has shown that some educational strategies aimed at facilitating implementation are more effective than others.[7,8] Formal continuing medical education conferences and the mailing of unsolicited materials have little impact on changing physician behavior. Moderately more effective methods include opinion leaders (clinicians identified by colleagues as respected clinicians and effective communicators) and audit with feedback. Effective strategies include reminder systems (posters, pocket cards, reminder sheets), educational outreach (for prescribing behavior), and strategies that involve two or more interventions.

EXAMPLES OF IMPLEMENTATION STUDIES IN THE EMERGENCY DEPARTMENT

Our research group has conducted derivation, validation, and implementation studies for four widely used CDRs. We review the results from implementation trials of the Ottawa Ankle Rules, the Ottawa Knee Rule, the Canadian C-Spine Rule, and the Canadian CT Head Rule.

The Ottawa Ankle Rules

Ankle and foot injuries are a common problem seen in emergency departments (EDs). While very few of these cases suffered a fracture, most patients underwent radiography before development of the Ottawa Ankle Rules.[9] The Ottawa Ankle Rules were derived (N = 750),[10] refined, and prospectively validated (N = 1,485)[11] before two implementation trials (Table 1).

Table 1
Multiple Phases to Develop the Ottawa Ankle Rules

Use and attitudes (N = 1,831)
CMAJ 1992[9]
Derivation of the rules (N = 750)
Ann Emerg Med 1992[10]
Prospective validation (N = 1,485)
JAMA 1993[11]
Local implementation trial (N = 2,342)
JAMA 1994[12]
Multicenter implementation trial (N = 12,777)
BMJ 1995[13]

Our first implementation trial (1992) was a before-after controlled clinical trial that assessed the use of radiography for 2,342 adult patients in two hospitals.[12] The Ottawa Ankle Rules were taught to all housestaff and emergency physicians (EPs) at the intervention hospital. The decision to refer patients for radiography was at the discretion of the treating physician. Telephone follow-up was attempted for all 140 patients discharged without radiography and all 295 patients discharged after radiography. The intervention site demonstrated a relative reduction (RR) in ankle radiography of 28%, while the control site had an increase of 2%. The study also found that patients discharged without radiography spent less time in the ED (80 minutes vs. 116 minutes) and did not differ in the proportion satisfied with care (95% vs. 96%) or the proportion undergoing subsequent radiography (5% vs. 5%). In the 12 months following the trial, the radiography rates remained the same at the intervention hospital.

The second implementation trial (1993) was a before-after controlled clinical trial, comparing two 12-month periods, conducted at five community and three teaching hospitals.[13] This trial assessed the use of radiography in 12,777 adults with acute ankle injuries. More than 200 physicians with varying experience were taught the Ottawa Ankle Rules through a one-hour lecture, pocket cards, and posters in the ED. There were significant reductions in the use of ankle radiography for all eight hospitals, with an overall RR of 26%. The a priori subgroups also demonstrated significant reductions: community hospitals, 29% RR; teaching hospitals, 23% RR; EPs, 25% RR; family physicians, 29% RR; and housestaff, 27% RR. For the radiography versus no radiography groups, there were no significant differences in satisfaction, days off work, subsequent visits, or subsequent radiography.

Strategies to implement the Ottawa Ankle Rules have included diffusion (abstracts, presentations, and manuscripts), dissemination (continuing medical education courses, review articles, editorials, pocket cards, posters, videos, and endorsement), and implementation strategies (opinion leaders, rounds, posters, reminder form, memos, draws, peer comparison). In 2001, a survey of EPs from the United Kingdom, France, Spain, the United States, and Canada was conducted to evaluate the international diffusion of the Ottawa Ankle Rules and physician attitudes toward them.[14] The results indicated that a majority of Canadian (89%) and U.K. (73%) EPs use the rules. However, less than one third of Spanish, French, and U.S. physicians reported frequent use of the rules.

The Ottawa Knee Rule

Traumatic knee injuries are also a common reason for ED visits.[15] The Ottawa Knee Rule incorporates simple patient history and physical findings to determine if patients need radiography following a traumatic knee injury. The Ottawa Knee Rule was derived (N = 1,047)[16] and

prospectively validated (N = 1,096)[17] before an evaluation of its impact on clinical practice (Table 2).

Our implementation study (1995–1996) was a controlled clinical trial at four hospitals involving 3,907 adult patients with acute knee injury.[18] The Ottawa Knee Rule was implemented on 1,063 patients at the two intervention hospitals. There was a RR of 26% in the proportion of patients referred for knee radiography in the intervention group versus a RR of 1% in the control group. No fractures were missed by applying the rule, and compared with patients without fracture who underwent radiography, patients discharged without radiography spent less time in the ED (86 minutes vs. 119 minutes).

The international survey that assessed awareness of the Ottawa Ankle Rules also assessed awareness and attitudes toward the Ottawa Knee Rule.[14] There was less awareness of the knee rule compared with the ankle rules. English-speaking countries reported the highest awareness of the rule (Canada, 63%; United States, 53%; United Kingdom, 29%), and France and Spain reported just 12% and 8%, respectively. These rates are reflected in the low numbers reporting use of the rule (only 17% in Canada).

The Canadian C-Spine Rule

The Canadian C-Spine Rule was developed after demonstrating large variation among Canadian EDs, and the physicians working in them, regarding the use of radiography for alert and stable trauma patients.[19] The rule was prospectively derived (N = 8,924)[20] and validated (N = 8,283)[21] before an implementation trial involving 11,648 patients at 12 hospital EDs.[22] Two further studies have subsequently validated the rule when used by paramedics (N = 3,000)[23] and by nurses (N = 4,000)[24] (Table 3).

The objective of the recently completed implementation trial (2003–2005) was to evaluate the effectiveness of implementing the Canadian C-Spine Rule in multiple EDs.[25] The matched-pair cluster design study compared three outcomes (impact on imaging use, adverse outcomes, and accuracy of the rule) during two 12-month before and after periods at 12 sites. The 12 sites were stratified by teaching or community hospital status, matched according to baseline imaging rates, and randomly allocated to intervention or control groups. During the after period at the intervention site, active strategies were used to implement the Canadian C-Spine Rule. These strategies included education (i.e., distribution of manuscripts, pocket cards, and posters as well as a one-hour teaching session), policy (i.e., consensus meetings to institute a process of care modification), and reminder of the rule at the point of requisition for cervical spine radiography.

Table 2
Multiple Phases to Develop the Ottawa Knee Rule

Use and attitudes (N = 3,007)
Acad Emerg Med 1995[15]
Derivation of the rule (N = 1,047)
Ann Emerg Med 1995[16]
Prospective validation (N = 1,096)
JAMA 1996[17]
Local implementation trial (N = 3,907)
JAMA 1997[18]

Table 3
Multiple Phases to Develop the Canadian C-Spine Rule

Variation in use of cervical spine radiography (N = 6,855)
CMAJ 1997[19]
Derivation of the rule (N = 8,924)
JAMA 2001[20]
Prospective validation (N = 8,283)
N Engl J Med 2003[21]
Multicenter implementation trial (N = 11,648)
Acad Emerg Med 2006[22]
International survey of attitudes and uptake (N = 223)
Can J Emerg Med 2006[26]
Validation by paramedics (N = 3,000)
Acad Emerg Med 2007[23]
Validation by emergency department nurses (N = 4,000)
Acad Emerg Med 2007[24]

Before the implementation trial, a survey was conducted to determine the likely barriers to EP use of the Canadian C-Spine Rule.[26] Several potential barriers were identified: preference for the National Emergency X-Radiography Utilization Study (NEXUS) rule, 12%; forget the rule details, 12%; other services will order anyway, 12%; requires too much time, 9%; lack of comfort with the rotation, 7%; evidence for the rules is flawed, 5%; not safe for patients, 2%; resent concept of guidelines, 2%. Other barriers included lack of student or resident knowledge of the rules, language barriers, patient expectations, and the notion that trauma referrals always require x-rays. While a minority of physicians identified specific barriers, the implementation strategies used for the trial attempted to target these important issues.

Results from the implementation trial have been presented but not yet published.[22] There was a very significant difference between the intervention and control sites going from the before to after period, with a reduction in imaging rates at the six intervention sites and an increase at the six control sites. There were no missed cervical spine injuries or adverse outcomes at the intervention sites. There were some important implementation issues identified. Compliance with requisition was more difficult to achieve than expected, and there were some interpretation errors (missed criteria and overcalled criteria) that should be addressed in future educational efforts.

The Canadian CT Head Rule

The use of computed tomography (CT) for minor head injury was variable among institutions and individual physicians, prompting the development of a CDR to standardize the efficient use of CT of the head.[27] The Canadian CT Head Rule was derived (N = 3,121)[28] and validated (N = 2,707)[29] before a multicenter implementation trial[30] (Table 4).

The recently completed implementation trial (2004–2006) used a matched-pair cluster randomized design and also compared 12-month before and after periods at 12 EDs. Sites were stratified by teaching or community hospital status and randomly assigned to intervention or control groups. All adult patients presenting with a Glasgow Coma Scale score of 13–15, after acute head trauma and transient neurologic impairment, were enrolled

Table 4
Multiple Phases to Develop the Canadian CT Head Rule

Variation in use of CT (*N* = 1,699)
Ann Emerg Med 1997[27]
Derivation of the rule (*N* = 3,121)
Lancet 2001[28]
Prospective validation (*N* = 2,707)
JAMA 2005[29]
Multicenter implementation trial (*N* = 4,531)
Acad Emerg Med 2007[30]

(*N* = 4,531). Active strategies (education, policy, and requisition reminders) to implement the Canadian CT Head Rule were introduced at the intervention sites in the after period. To date, the results of this trial have only been published in abstract form but are quite unlike the positive findings of the C-Spine Rule implementation study. We found that the CT Head Rule trial had no impact on CT imaging use, with rates increasing from before to after at both the control and the intervention hospitals.

Very surprisingly, this knowledge transfer trial failed to demonstrate the impact of the previously validated Canadian CT Head Rule on CT imaging rates. We are currently conducting qualitative research to better understand the reasons for this failure of knowledge uptake. Among a variety of potential barriers, we believe that physician compliance was the major issue. We conducted a survey of participating physicians before the implementation trial and identified several potential barriers to implementation of the Canadian CT Head Rule.[26] Thirty-two percent of physicians indicated that they would forget the details of the rule; 30% indicated that other services would order the CT anyway; 10% indicated the patient/family expectations were an issue; 6% believed the research is flawed, failed to see the advantage of not ordering a CT, or could not afford the observation time in a busy ED; 2% indicated that application of the rule takes too much time; and 2% believed the rule was not safe for patients. A poststudy survey that examined participating physicians' perceptions of the failure of the study identified problems with application of the rule, physicians' beliefs and attitudes, issues surrounding busy and overcrowded EDs, and the notion that CT of the head is considered "standard of care." We hope that further qualitative research will better explain this negative study.

CONCLUSIONS

Well-developed and validated CDRs can be successfully implemented into EDs to efficiently standardize care. However, this success is not universal. While we found that four different implementation trials significantly and safely altered physician behavior, a recent trial had no impact whatsoever. Future research should identify implementation barriers and explore strategies to achieve better knowledge uptake in the ED.

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