The Out-of-Hospital Validation of the Canadian C-Spine Rule by Paramedics

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Study objective: We designed the Canadian C-Spine Rule for the clinical clearance of the cervical spine, without need for diagnostic imaging, in alert and stable trauma patients. Emergency physicians previously validated the Canadian C-Spine Rule in 8,283 patients. This study prospectively evaluates the performance characteristics, reliability, and clinical sensibility of the Canadian C-Spine Rule when used by paramedics in the out-of-hospital setting.

Methods: We conducted this prospective cohort study in 7 Canadian regions and involved alert (Glasgow Coma Scale score 15) and stable adult trauma patients at risk for neck injury. Advanced and basic care paramedics interpreted the Canadian C-Spine Rule status for all patients, who then underwent immobilization and assessment in the emergency department to determine the outcome, clinically important cervical spine injury.

Results: The 1,949 patients enrolled had these characteristics: median age 39.0 years (interquartile range 26 to 52 years), female patients 50.8%, motor vehicle crash 62.5%, fall 19.9%, admitted to the hospital 10.8%, clinically important cervical spine injury 0.6%, unimportant injury 0.3%, and internal fixation 0.3%. The paramedics classified patients for 12 important injuries with sensitivity 100% (95% confidence interval [CI] 74% to 100%) and specificity 37.7% (95% CI 36% to 40%). The κ value for paramedic interpretation of the Canadian C-Spine Rule (n=155) was 0.93 (95% CI 0.87 to 0.99). Paramedics conservatively misinterpreted the rule in 320 (16.4%) patients and were comfortable applying the rule in 1,594 (81.7%). Seven hundred thirty-one (37.7%) out-of-hospital immobilizations could have been avoided with the Canadian C-Spine Rule.

Conclusion: This study found that paramedics can apply the Canadian C-Spine Rule reliably, without missing any important cervical spine injuries. The adoption of the Canadian C-Spine Rule by paramedics could significantly reduce the number of out-of-hospital cervical spine immobilizations. [Ann Emerg Med. 2009;54:663-671.]

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INTRODUCTION

Background

North American emergency medical services (EMS) annually transport more than 1 million trauma patients with a suspected cervical spine injury.[1] Approximately 2% of these patients have a cervical spine fracture, and less than 1% develop neurologic deficits.[2] Because of the potential for spinal cord injury, out-of-hospital trauma guidelines usually recommend that paramedics protect the cervical spine of trauma patients during ambulance transport, which is usually achieved by such measures as a

Editor's Capsule Summary

What is already known on this topic

Can paramedics apply the Canadian C-Spine Rule in alert, stable, cooperative, blunt-trauma patients to reserve spinal immobilization for high-risk patients while avoiding immobilization for low-risk patients?

What question this study addressed

Can paramedics apply the Canadian C-Spine Rule in alert, stable, cooperative, blunt-trauma patients to reserve spinal immobilization for high-risk patients while avoiding immobilization for low-risk patients?

What this study adds to our knowledge

In this 1,949-patient cohort, paramedics achieved 100% sensitivity and 38% specificity for important cervical fractures.

How this might change clinical practice

Use of the Canadian C-Spine Rule by paramedics may safely avoid unnecessary spinal immobilization.

backboard, a cervical spine collar, and head immobilization.[3] This general protocol is often followed regardless of whether the patient is fully alert and stable and regardless of whether the patient was ambulatory at the scene. This practice is not evidence based, but rather the result of region-specific protocols developed by EMS medical directors. A Cochrane Review found no evidence that spinal immobilization lessens mortality or neurologic injury or improves spinal stability during transport.[4]

Importance

Cervical spine immobilization in the field is often unnecessary, is time intensive for paramedics in the field, and is very uncomfortable for patients. The potential for multiple clinical and system adverse effects and discomfort with immobilization have been well documented. Chest straps used in immobilization have a marked pulmonary restrictive effect, even in healthy nonsmokers.[5] Immobilization on a board leads to progressively worse pain in the head, neck, and back area, often resulting in the necessity to radiograph the spine in the emergency department (ED).[6] Immobilized patients consume valuable ED space, require immediate attention from physicians, nurses, and radiology technicians, and aggravate the problem of ED crowding.[7,8]

Goal of This Investigation

Clinical decision rules attempt to reduce the uncertainty of medical decisionmaking by standardizing the collection and interpretation of clinical data.[9] We designed the Canadian C-Spine Rule to allow physicians to clear the cervical spine in a few minutes by means of simple questions and assessment. This rule is based on 3 high-risk criteria, 5 low-risk criteria, and the ability of patients to rotate their neck. We derived and validated the Canadian C-Spine Rule in 2 large multicenter studies involving a total of 17,207 alert and stable ED trauma patients.[2,10] Several investigators have used other decision rules to evaluate the potential for paramedics to clear the cervical spine in the field and avoid immobilization,[11-13] but all resulted in missed cervical spine injuries. The goal of this study is to prospectively assess the performance characteristics, reliability, and clinical sensibility of the Canadian C-Spine Rule for alert, stable, and cooperative trauma patients when used by paramedics in the out-of-hospital setting.

MATERIALS AND METHODS

Study Design

We conducted a prospective multicenter cohort study to evaluate a convenience sample of trauma patients assessed in the field by advanced and basic care paramedics using the Canadian C-Spine Rule.

Setting

This national study took place between 2002 and 2006 in 7 locations, with populations ranging from 70,876 to 935,106, distributed in 3 Canadian provinces: Ontario (Ottawa, Windsor, Halton, Sarnia, and Niagara Falls), Alberta (Calgary), and Nova Scotia (Industrial Cape Breton, Kentville, Truro, and Bridgewater). All sites have sophisticated EMS services, with first-responding firefighters and second-tier basic care and advanced care paramedics. The Ontario communities share a central computerized ambulance response information system and a common ambulance call report. Nova Scotia also benefits from a uniform response information system and a common ambulance call report used throughout the province. Participation of paramedics in this study was voluntary.

Selection of Participants

We enrolled a convenience sample of alert, stable, and cooperative patients transported by ambulance to local hospitals after sustaining acute blunt trauma with potential injury to the neck. These are patients for whom standard EMS protocols require immobilization. We defined "alert" as a Glasgow Coma Scale[14] score of 15 (converses, fully oriented, and follows commands). "Stable" refers to normal vital signs as defined by the Revised Trauma Score[3] (systolic blood pressure 90 mm Hg or greater and respiratory rate between 10 and 24 breaths/min on arrival). "Cooperative" indicates that the patient willingly follows commands and is not agitated. "Acute" refers to injury within the past 8 hours. "Trauma with potential injury to the neck" included patients with either posterior neck pain with any blunt mechanism of injury, or no neck pain but some visible injury above the clavicles. Patients were ineligible if they were younger than 16 years, had a penetrating trauma to the neck, were acutely paralyzed (paraplegia, quadriplegia), or had known vertebral disease (ankylosing spondylitis, rheumatoid arthritis,

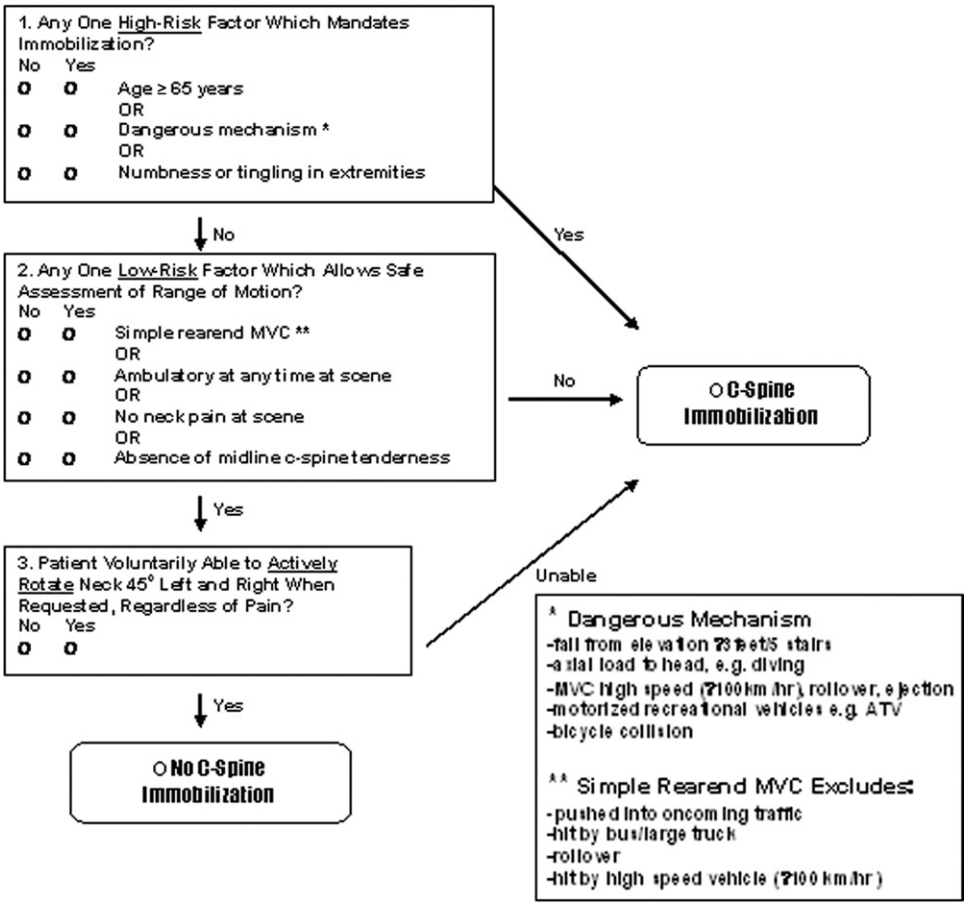

Figure 1. The Canadian C-Spine Rule for alert (Glasgow Coma Scale score 15) and stable trauma patients for whom cervical spine injury is a concern, including patients with either posterior neck pain with any blunt mechanism of injury or no neck pain but some visible injury above the clavicles. *MVC,* Motor vehicle crash.

spinal stenosis, or previous cervical spine surgery). The research ethics board at each participating institution approved the study and waived the requirement for written informed consent, with the exception of Nova Scotia, where written consent was necessary before enrollment.

Methods of Measurement

Every paramedic completed a 2-hour Web-based training session, followed by a practical demonstration using case scenarios to assess the Canadian C-Spine Rule uniformly. Paramedics subsequently assessed patients in the field by using the Canadian C-Spine Rule, recorded their findings, along with their interpretation of the decision rule itself, on a standard data collection form before arrival at the hospital, and proceeded to immobilize all patients before transport, as per their current protocol. Before the start of the trial, paramedics from Calgary and Nova Scotia could decide not to immobilize patients for transport, following local protocols; they continued to selectively immobilize patients as part of this study, but using the Canadian C-Spine Rule instead. EMS supervisors and study personnel were always available to answer questions, during and between patient evaluations.

We have slightly revised the Canadian C-Spine Rule for out-of-hospital use (Figure 1). We removed the low-risk criteria pertaining to "delayed onset of neck pain" because paramedics were going to assess patients before such a delay would occur. We asked paramedics to measure the clinical sensibility related to the interpretation and use of the Canadian C-Spine Rule by indicating whether cervical spine immobilization was indicated or not according to the decision rule and how comfortable they would be (5-point scale from "very comfortable" to "very uncomfortable") if in fact following the rule's recommendation for each patient assessed. Time permitting, some patients were assessed independently by a second paramedic to determine interobserver agreement.

Outcome Measures

The primary outcome, acute cervical spine injury, was defined as any fracture, dislocation, or ligamentous instability demonstrated by radiographic imaging. All injuries were considered clinically important unless radiography, including computed tomography (CT) and flexion-extension views, demonstrated one of the following isolated clinically unimportant cervical spine injuries: avulsion fracture of

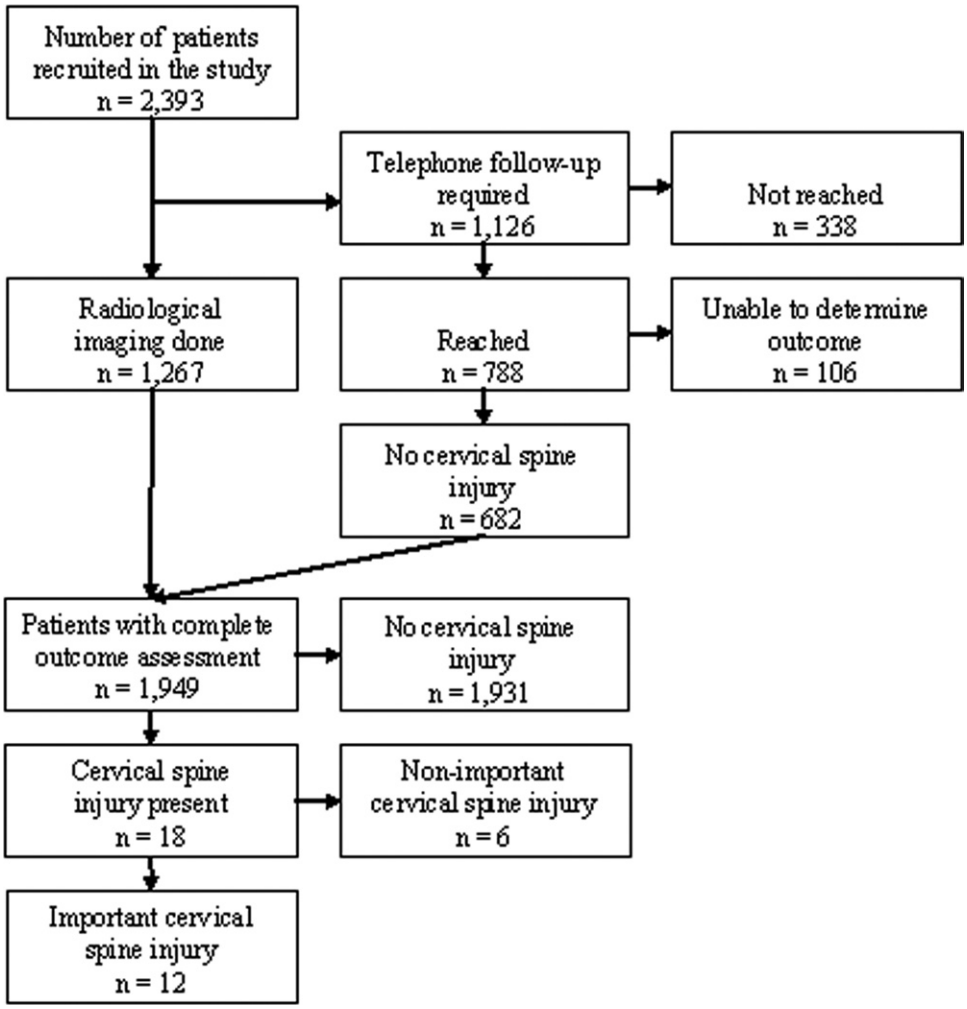

Figure 2. Flow of patients recruited in the study.

osteophyte, fracture of transverse process not involving facet joint, fracture of spinous process not involving lamina, or simple compression fracture less than 25% of vertebral body height. This definition of clinically important cervical spine injury was standardized according to the results of a formal survey of 129 neurosurgeons, spine surgeons, neuroradiologists, and emergency physicians at 8 Canadian academic centers.[15] Emergency physicians at each receiving hospital determined whether patients required cervical spine imaging according to their clinical evaluation, which may have included using the Canadian C-Spine Rule. For those imaged, standard diagnostic imaging may have included plain radiography, oblique views, flexion-extension views, and CT at the discretion of the treating physician. Staff radiologists interpreting the radiographs were provided with routine clinical information but not the contents of the data form.

We asked a study nurse to contact all enrolled patients who did not have diagnostic imaging by telephone or mail within 14 days and classified them as having no acute cervical spine injury if they met all the following explicit criteria: (1) pain in neck is rated as none or mild, (2) restriction of movement of neck is rated as none or mild, (3) does not require use of a neck collar, and (4) neck injury has not prevented return to usual occupational activities (work, housework, or school). The nurse assessing these criteria was unaware of the patient's status for the Canadian C-Spine Rule. Patients who could not fulfill these criteria were recalled for clinical reassessment and cervical spine radiography. The validity of these criteria to exclude acute cervical spine injury was previously determined in a substudy in which the telephone follow-up questionnaire was applied to a random sample of study patients with and without cervical spine injury and who had all undergone radiography.[16] The questionnaire proved to be 100% sensitive for identifying 66 abnormal cases among the 389 radiography patients reached by telephone.

Primary Data Analysis

We measured the performance characteristics of the rule for identifying acute cervical spine injury, as well as the performance characteristics of the interpretation of the rule by

Table 1. Characteristics of the 1,949 enrolled study patients with complete outcome assessment.

Characteristic	Value	Characteristic	Value
Age, y		**Characteristics of motor vehicle crash, No. (%)**	
Median (interquartile range)	39.0 (26–52)	Simple rear-end crash	336 (17.2)
Range	16, 103	Rollover	124 (6.4)
Female sex, No. (%)	990 (50.8)	Head-on crash	49 (2.5)
Mechanism of injury, No. (%)		Ejection from vehicle	9 (0.5)
Motor vehicle crash	1,218 (62.5)	Death of other(s) in same crash	4 (0.2)
Motorcycle crash	41 (2.1)		
Crash involving other motorized vehicles	21 (1.1)	**Cervical-spine radiography performed, No. (%)**	1,267 (65.0)
Bicycle struck	36 (1.8)	**Outcome by telephone follow-up, No. (%)**	682 (35.0)
Bicycle crash	25 (1.3)	**Acute cervical-spine injury, No. (%)**	18 (0.9)
Other bicycle accident	29 (1.5)	Fracture	14 (0.7)
Pedestrian struck	44 (2.3)	Dislocation	3 (0.2)
Pedestrian struck and thrown	30 (1.5)	Ligamentous instability	7 (0.4)
Fall from elevation <3 ft (1 m) or down <5 stairs	209 (10.7)	**Clinically important cervical spine injury, No. (%)**	12 (0.6)
Fall from elevation of 3–10 ft (1–3 m) or down 5–15 stairs	108 (5.5)		
Fall from elevation >10 ft (3 m) or down >15 stairs	70 (3.6)	**Stabilizing treatments, No. (%)**	6 (0.3)
Fall onto head (axial load)	1 (0.1)	Internal fixation	5 (0.3)
Heavy object onto head (axial load)	9 (0.5)	Halo	1 (0.1)
Contact sport (axial load)	16 (0.8)	Brace	2 (0.1)
Diving	2 (0.1)	Rigid collar	3 (0.2)
Other sport	21 (1.1)		
Assault with fist or feet	33 (1.7)	**Admitted to hospital, No. (%)**	210 (10.8)
Assault with a blunt object	14 (0.7)		
Head struck by other object	11 (0.6)		
Hit head on an object	5 (0.3)		
Other	6 (0.3)		

We defined acute cervical spine injury as any fracture, dislocation, or ligamentous instability demonstrated by radiographic imaging. All injuries are considered clinically important unless radiography, including CT and flexion-extension views, demonstrates one of the following isolated clinically unimportant cervical spine injuries: avulsion fracture of osteophyte, fracture of transverse process not involving facet joint, fracture of spinous process not involving lamina, or simple compression fracture less than 25% of vertebral body height.

the attending paramedics with 95% confidence intervals (CIs) for sensitivity, specificity, and negative predictive value. The final interpretation of the rule, ie, positive or negative for cervical spine injury, was made by the investigators according to the status of the patient for the component variables, as documented by the attending paramedic on their study data collection sheet or patient care reports. We assessed the reliability of the rule by using the κ coefficient for each variable and for the interpretation of the rule between paramedics. We estimated the clinical sensibility of the rule by reporting paramedics' theoretical comfort in using the rule and the potential of the rule for reducing the number of patients requiring immobilization if the rule had been applied. We performed all analyses with SAS statistical software, version 9.1 (SAS Institute, Inc., Cary, NC).

RESULTS

Characteristics of Study Subjects

We enrolled 2,393 eligible patients in the study between May 2002 and June 2006 (Figure 2). One thousand one hundred twenty-six patients were not evaluated with cervical spine radiography and required telephone follow-up. We reached 788 (70.0%) of those patients, among which 682 were determined to not have sustained a cervical spine injury, according to our validated proxy assessment tool. A total of 1,949 enrolled patients had complete outcome assessments, and the characteristics of these study patients are presented in Table 1; 12 (0.6%) had a clinically important cervical spine injury. In 2 cases, the investigators could perform an independent assessment of the rule according to the paramedic care report but could not evaluate the paramedic assessment of the rule according to their study data collection sheet. The characteristics of the 444 patients without outcome assessments were similar to those with radiographic evaluation but were less likely to be admitted to the hospital (Table E1, available online at http://www.annemergmed.com).

The distribution of various elements of the Canadian C-Spine Rule among the 1,947 patients assessed by paramedics is detailed in Table 2; 944 (48.5%) were believed to have at least 1 of the high-risk factors mandating immobilization. Among the remaining 1,003 participants, 927 (92.4%) had at least 1 low-risk factor, allowing for safe assessment of neck range of motion. Range of motion was evaluated in 761 (82.1%) of these 927 patients and was successful in 731.

Paramedics conservatively misinterpreted the rule in 320 patients (16.4%), including 154 cases (7.9%) in which "dangerous mechanism" was overcalled and 166 cases (8.5%) in

Table 2. Distribution of various elements of the Canadian C-Spine Rule among 1,947 patients* assessed by paramedics.

Canadian C-Spine Rule Elements	Number of Patients†
Assessed for high-risk factor (n=1,947)	
Age 65 y or older	205
Dangerous mechanism	670
Paresthesias in extremities	192
Assessed for low-risk factor (n=1,003)	
Simple rear-end motor vehicle crash	261
Ambulatory at any time at scene	602
No neck pain at scene	422
Absence of midline cervical spine tenderness	371
Assessment of neck rotation possible (n=927)	
Patient able to actively rotate neck	731
Paramedics did not attempt to evaluate neck rotation	166

*In 2 cases, we could not evaluate the paramedic assessment of the rule according to their study data collection sheet. We omitted these 2 cases from the paramedic assessment analysis.
†A patient can have more than 1 element of the decision rule.

Table 3. Sensitivity, specificity, and negative predictive value of the Canadian C-Spine Rule for 12 cases of clinically important injury among 1,629 patients* assessed by the study investigators and 1,947 patients† assessed by the participating paramedics.

	Investigators (95% CI)		Paramedics (95% CI)	
Result of Assessment	**Injury**	**No Injury**	**Injury**	**No Injury**
Positive, No.	12	924	12	1,204
Negative, No.	0	693	0	731
Sensitivity, %	100 (74–100)		100 (74–100)	
Specificity, %	42.9 (40–45)		37.7 (36–40)	
Negative predictive value, %	100 (99–100)		100 (99–100)	

*In 320 cases, the investigators could not perform an independent assessment of the rule according to the documentation provided by paramedics (including 166 cases in which neck rotation was not attempted, as required by the rule). We classified these cases as indeterminate for the rule and omitted them for this analysis.
†In 2 cases, the investigators could perform an independent assessment of the rule according to the paramedic care report but could not evaluate the paramedic assessment of the rule according to their study data collection sheet. We omitted these 2 cases from the paramedic assessment analysis.

which paramedics did not evaluate neck rotation as required by the Canadian C-Spine Rule. The Canadian C-Spine Rule assessment for these patients was later categorized by the investigators as "indeterminate." Patient characteristics for these 320 patients were similar to those for which the rule was followed accurately, with the exception that none of the 320 patients had a cervical spine injury (Table E2, available online at http://www.annemergmed.com). Paramedics did not attempt to evaluate neck rotation in any of the 12 patients with a clinically important injury.

Main Results

The performance characteristics of the Canadian C-Spine Rule as assessed by the investigators and by the paramedics are compared in Table 3. The sensitivity of the rule was 100% (95% CI 74% to 100%), regardless of whether the assessment was performed by the investigators or the paramedics. The specificity of the rule was 42.9% (95% CI% 40 to 45%) when assessed by investigators compared with 37.7% (95% CI 36% to 40%) when assessed by paramedics. The negative predictive value of the rule was 100% (95% CI 99% to 100%) for both investigators and paramedics.

We performed secondary analyses involving all 1,949 patients to determine the potential effect of indeterminate cases when the rule was assessed by paramedics. When the rule was assumed to be positive for all indeterminate cases, the specificity was 32.4% (95% CI 31% to 34%), and when the rule was assumed to be negative for all indeterminate cases, the specificity was 46.6% (95% CI 45% to 49%). The sensitivity and negative predictive value remained the same because there were no cervical spine injuries among the indeterminate cases.

We assessed the reliability of paramedic interpretation of the rule by measuring the κ coefficient for interobserver agreement for each element of the rule (Table 4). The κ value for the overall interpretation of the rule was 0.93 (95% CI 0.87 to 0.99). A value greater than 0.80 is generally considered to reflect almost perfect agreement.[17]

We assessed the clinical sensibility of the rule in 2 ways. First, we measured the acceptability of the rule by using a 5-point Likert scale, ranging from "very uncomfortable" to "very comfortable." Paramedics were "very uncomfortable" or "uncomfortable" applying the Canadian C-Spine Rule in 9.5% of cases; they were "comfortable" or "very comfortable" in 81.7% of cases. We also evaluated the potential effect of the rule on the number of necessary immobilizations. If paramedics were allowed to use the rule, 62.2% (95% CI 60% to 64%) of recruited patients would have required immobilization in the field compared with the actual immobilization rate of 100%.

LIMITATIONS

Our study contains several potential limitations. First, although we enrolled a large number of patients, our sample only included 12 cases with a clinically important cervical spine injury. Although paramedics were able to identify all 12 cases by using the Canadian C-Spine Rule in the field, it is possible they could have missed an injury, had our sample size been larger. Other out-of-hospital studies included a larger number of cases with significant cervical spine injury.[11-13,18,19] They all reported missing some cervical spine injury cases, none of which resulted in neurologic injury. A comparison between a US EMS system with full immobilization before transportation and Kuala Lumpur, Malaysia, with no immobilization found no difference in the neurologic outcomes of 454 patients with blunt spinal injuries.[20] Because the Canadian C-Spine Rule performed extremely well in a recent large inhospital validation study,[2] and because the mode of transportation does not seem to influence neurologic outcomes in patients with blunt cervical spine

Table 4. κ values for individual clinical variables in the Canadian C-Spine Rule among 155 interobserver paramedics.

Clinical Variables	Medic 2	Medic 1 Yes	Medic 1 No	κ Value	95% CI
Age 65 y or older	Yes	21	0	0.97	0.92–1.00
	No	1	131		
Dangerous mechanism	Yes	55	3	0.93	0.87–0.99
	No	2	83		
Paresthesias in extremities	Yes	18	1	0.94	0.85–1.00
	No	1	95		
Simple rear-end motor vehicle crash	Yes	16	1	0.84	0.68–0.99
	No	3	35		
Ambulatory at any time at scene	Yes	42	0	1.00	1.00–1.00
	No	0	16		
No neck pain at scene	Yes	27	2	0.89	0.76–1.00
	No	1	23		
Absence of midline cervical spine tenderness	Yes	38	1	0.83	0.66–0.99
	No	3	14		
Able to rotate neck	Yes	54	1	0.66	0.03–1.00
	No	0	1		
Overall interpretation of the rule	Yes	97	3	0.93	0.87–0.99
	No	2	53		

injuries, we do not believe that a larger sample size would have significantly altered our results.

Second, not all patients were evaluated with diagnostic imaging in the ED. Many emergency physicians already use the Canadian C-Spine Rule combined with their clinical judgment to limit the number of radiographs conducted in low-risk patients. However, these patients were classified as having "no important cervical spine injury" only if they satisfied all criteria of a validated proxy outcome assessment tool.[16]

Third, some patients could not be reached or be classified as having "no important cervical spine injury" with our proxy outcome assessment tool. It is unlikely that any of these patients had a missed injury because none returned to the treating hospital or visited their local neurosurgical referral center. These patients had characteristics that were similar to those for which radiologic outcomes were known, with the exception of being less likely to require admission to the hospital.

Fourth, neck rotation was not evaluated in some cases in which it would have been appropriate to do so according to rule; the interpretation of the rule became indeterminate as a result, mostly because of the conservative misinterpretation of the "dangerous mechanism" element of the rule by some paramedics. It is also probable that some of them were uncomfortable with diverging from current practice and asking a selected group of patients to rotate their neck. Secondary analyses incorporating the indeterminate cases did not affect the performance of the rule. None of the patients classified as having indeterminate injury had a cervical spine injury.

Finally, paramedics were allowed to recruit patients in the study at their discretion. It is possible that paramedics systematically did not recruit more severely injured patients for the study. That being said, our sample had a slightly lower prevalence rate of cervical spine injury but a higher hospital admission rate compared with our previous large inhospital validation study.[2]

DISCUSSION

Despite only a short tutorial on how to use and interpret the Canadian C-Spine Rule, paramedics were able to identify all 12 patients for which an important cervical spine injury was present. The sensitivity and negative predictive value of the rule were both 100%, regardless of whether the rule was interpreted by the investigators or the paramedics. Although we report a wide CI around our point estimate for the sensitivity of the rule to identify all the injuries, this is purely a result of our population size, as discussed earlier.

The rule was reliable, as expressed by the very high level of agreement among interobserver paramedics for each element of the rule, as well as for their overall interpretation of the rule. Although paramedics usually agreed with one another, they had some difficulty with the "dangerous mechanism" element of the rule. They often mislabeled an event believed to be of significant

mechanism when in fact it was not a dangerous mechanism mentioned by the rule. This misinterpretation of the rule could have been avoided with a better understanding that, although not mentioning all possible dangerous mechanisms, the rule was designed to identify all injury cases by using its subsequent elements or questions. On the other hand, we prefer this cautious interpretation of the rule, rather than the inappropriate evaluation of neck rotation in patients with a cervical injury, which never occurred in this study.

Paramedics were comfortable or very comfortable using the Canadian C-Spine Rule in the majority of cases. Once again, most cases for which paramedics were uncomfortable using the rule related to incidents in which a dangerous mechanism was believed to be present, yet was not specifically mentioned by the rule. After they were evaluated by paramedics using the Canadian C-Spine Rule, all patients were immobilized, as is current practice before transportation to the hospital. A large number of these immobilizations could have been avoided, had we allowed the paramedics to make clinical decisions based on their interpretation of the rule. This could lead to significant reductions in out-of-hospital time spent on scene and possibly reduction of crowding in the ED.[2]

In summary, to our knowledge this is the first study validating the use of the Canadian C-Spine Rule in the field by paramedics. We found that the rule was accurate and reliable when used by paramedics, who successfully identified all 12 patients with clinically important cervical spine injury. Widespread use of the rule by paramedics could reduce the number of unnecessary cervical spine immobilizations in the field.

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New Resident Fellows Announced

Each year, *Annals of Emergency Medicine* selects a Resident Fellow (formerly the Resident Editor) to serve on the Editorial Board. We are pleased to announce that Jason D. Heiner, MD, of Madigan Army Medical Center, Fort Lewis, WA, and Nadia Huancahuari, MD, of Boston Medical Center, Boston, MA, have been selected to serve as the new Editorial Board Resident Fellows for the coming year. Dr. Heiner received his MD in 2006 from the University of Vermont College of Medicine. Dr. Huancahuari received her MD in 2007 from the University of California Davis School of Medicine.

Aaron M. Brown, MD, of University of Pittsburgh, and Suzanne Lippert, MD, MS, of Alameda County Medical Center – Highland Campus, are the immediate past Resident Fellows for the journal. Dr. Brown and Dr. Lippert began their terms in October 2008. Their service concluded in October 2009.

If you have an idea, an issue, or an experience about which you would like to write, submit an abstract (limit 250 words, double-spaced) outlining your idea. Give the names of your coauthors, if any. If your idea is chosen, you will be asked to write and article for the "Residents' Perspective" section. Submit your abstract to Jason Heiner, MD, or Nadia Huancahuari, MD, Resident Fellows, *Annals of Emergency Medicine*, 1125 Executive Circle, Irving, TX 75038-2522. Fax: 972-580-0051. E-mail: annalsfellow@acep.org.

Table E1. Characteristics of the 444 patients without complete outcome assessment compared with the 1,949 enrolled study patients with complete outcome assessment.

Characteristic	Patients Without Complete Outcome, N=444	Patients With Complete Outcome, N=1,949
Age, y		
Median (interquartile range)	39.0 (26–53)	39.0 (26–52)
Range	16, 93	16, 103
Female sex, No. (%)	237 (53.4)	990 (50.8)
Mechanism of injury, No. (%)		
Motor vehicle crash (most common)	285 (64.2)	1,218 (62.5)
Characteristics of motor vehicle crash, No. (%)		
Simple rear-end crash	65 (14.6)	336 (17.2)
Rollover	27 (6.1)	124 (6.4)
Head-on crash	17 (3.8)	49 (2.5)
Ejection from vehicle	0	9 (0.5)
Death of other(s) in same crash	0	4 (0.2)
Admitted to hospital, No. (%)	28 (6.3)	210 (10.8)

Table E2. Characteristics of the 320 patients for whom the Canadian C-Spine Rule was conservatively misinterpreted by the paramedics compared with the 1,629 study patients for whom it was properly applied.

Characteristic	Rule Misinterpreted, N=320	Rule Correctly Applied, N=1,629
Age, y		
Median (interquartile range)	34 (25–47)	40.0 (26–54)
Range	16, 71	16, 103
Female sex, No. (%)	165 (51.6)	825 (50.6)
Mechanism of injury, No. (%)		
Motor vehicle crash (most common)	230 (71.9)	988 (60.7)
Characteristics of motor vehicle crash, No. (%)		
Simple rear-end crash	77 (24.1)	259 (15.9)
Rollover	1 (0.3)	123 (7.6)
Head-on crash	11 (3.4)	38 (2.3)
Ejection from vehicle	0	9 (0.6)
Death of other(s) in same crash	1 (0.3)	3 (0.2)
Acute cervical spine injury, No. (%)	0	18 (1.1)
Fracture	0	14 (0.9)
Dislocation	0	3 (0.2)
Ligamentous instability	0	7 (0.4)
Clinically important cervical spine injury, No. (%)	0	12 (0.7)
Stabilizing treatments, No. (%)	0	6 (0.4)
Internal fixation	0	5 (0.3)
Halo	0	1 (0.1)
Brace	0	2 (0.1)
Rigid collar	0	3 (0.2)
Admitted to hospital, No. (%)	24 (7.5)	186 (11.4)

We defined acute cervical spine injury as any fracture, dislocation, or ligamentous instability demonstrated by radiographic imaging. All injuries are considered clinically important unless radiography, including CT and flexion-extension views, demonstrates one of the following isolated clinically unimportant cervical spine injuries: avulsion fracture of osteophyte, fracture of transverse process not involving facet joint, fracture of spinous process not involving lamina, or simple compression fracture less than 25% of vertebral body height.