CRD summary
This generally well-conducted review concluded that both the Canadian C-spine rule and National Emergency X-Radiography Utilization Study (NEXUS) criteria had consistently high sensitivity and were, therefore, useful for ruling out clinically important cervical spine injury; the Canadian C-spine rule appeared to have better diagnostic accuracy than the NEXUS criteria. The conclusions are likely to be reliable.

Authors' objectives
To investigate the diagnostic accuracy of the Canadian C-spine rule and National Emergency X-Radiography Utilization Study (NEXUS) criteria used to assist emergency physicians to assess the need for cervical spine imaging.

Searching
MEDLINE, EMBASE and CINAHL were searched without language restrictions from inception to September 2011; the search strategies were reported in an online appendix. Reference lists of included studies and relevant systematic reviews were searched.

Study selection
Diagnostic cohort studies that evaluated use of the Canadian C-spine rule or NEXUS criteria for assessing the potential of clinically important cervical spine injury in patients who presented with symptoms of cervical spine injury following blunt trauma were eligible for inclusion. Studies had to confirm diagnosis using an adequate reference standard (examples provided) and report sufficient data to construct 2x2 tables of test performance.

Prevalence of clinically important spinal injury ranged from 0.4% to 6%. Where reported from 46% to 65% of participants were men. The mechanism of injury was a motor vehicle accident in most patients. A range of health professionals were used to apply the rules; most were emergency physicians. The reference standards were radiography or computed tomography.

Two reviewers independently selected studies for the review; disagreements were resolved by discussion or referral to a third reviewer.

Assessment of study quality
Study quality was assessed by two independent reviewers using the adapted 11-point QUADAS tool. Disagreements were resolved by discussion or referral to a third reviewer.

Data extraction
Two reviewers independently extracted data to construct 2x2 tables of test performance from which sensitivity and specificity were calculated. Positive and negative likelihood ratios (LR+ and LR-) and post-test probabilities were calculated. Where there were zero cells, 0.5 was added. Disagreements were resolved by discussion or referral to a third reviewer.

Methods of synthesis
Studies were combined in a narrative synthesis due to the clinical heterogeneity across studies. Differences between studies were discussed in the text and study details were tabulated. Results were presented graphically on forest plots with the pooled results omitted. Ranges of sensitivity and specificity were reported and medians were reported with interquartile ranges (IQR) for likelihood ratios for all studies and also separately for studies that used the Canadian C-spine rule unadapted and prospectively.

Results of the review
Fifteen studies were included in the review (79,526 patients, range 80 to 34,069); 12 were prospective and three
retrospective. Six studies enrolled consecutive patients. Eight studies avoided partial verification bias. Six studies avoided differential verification bias. Eight studies avoided progression bias. Eleven studies avoided incorporation bias. Five studies blinded interpreters of the reference standard and seven studies blinded interpreters of the index test. Four studies did not report on uninterpretable results. Nine studies explained withdrawals. Where reported, loss to follow-up was up to 18.6%. Radiography was conducted as part of the reference standard in 45% to 100% of patients.

**Canadian C-spine rule (nine studies):** Sensitivity ranged from 90% to 100%. Specificity ranged from 1% to 77%. The fraction of false negatives ranged from 0% to 0.11%. Median LR- was 0.18 (IQR 0.03 to 0.24) and median LR+ was 1.69 (IQR 1.57 to 1.81).

**NEXUS (seven studies):** Sensitivity ranged from 83% to 100%. Specificity from 13% to 46%. The fraction of false negatives ranged from 0% to 1.0%. Median LR- was 0.30 (IQR 0.19 to 0.41) and median LR+ was 1.44 (IQR 1.14 to 1.52).

One direct comparison reported that the Canadian C-spine rule had better accuracy than NEXUS and reduced imaging rates by 44% compared to 36% for NEXUS. Results were reported for prospective studies that used the rule unadapted.

**Authors’ conclusions**
The Canadian C-spine rule appeared to have better diagnostic accuracy than the NEXUS criteria. Both rules had consistently high sensitivity which indicated that a negative test result was highly informative in excluding a clinically important cervical spine injury and, therefore, the need for radiographic examination.

**CRD commentary**
The review addressed a clear question supported by reproducible inclusion criteria. Several relevant sources were searched without language restrictions or diagnostic filters; unpublished studies were not sought so some studies may have been missed. Each stage of the review was conducted in duplicate which reduced risks of error and bias. Study quality was assessed using appropriate criteria and the results were reported in full.

None of the studies met all the quality criteria and all were subject to high or unclear risk of bias. Studies were combined in a narrative synthesis; from the few study details provided, clinical heterogeneity did not appear to be sufficiently great to preclude the use of one of the robust summary receiver operating characteristic models from which pooled estimates of sensitivity and specificity could have been derived.

This was a generally well-conducted review based on a large overall population and the conclusions are likely to be reliable.

**Implications of the review for practice and research**

**Practice:** The authors stated that improved education of physicians may facilitate greater use of the assessment rules and educating patients may improve their utilisation.

**Research:** The authors stated that future studies needed to follow rigorous methodologic procedures to ensure that the findings were as free of bias as possible. They also stated that evaluation of these tools in settings outside of emergency departments, in paediatric and older populations and by primary care physicians was required. The authors provided an outline for an optimal diagnostic study design for future studies in an online appendix.

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**Bibliographic details**
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Record Status
This is a critical abstract of a systematic review that meets the criteria for inclusion on DARE. Each critical abstract contains a brief summary of the review methods, results and conclusions followed by a detailed critical assessment on the reliability of the review and the conclusions drawn.