SELECTED ARTICLES

Clinical criteria to rule out cervical spine injury

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Clinical question
Can clinical criteria be used to safely eliminate the need for cervical spine (C-spine) x-rays in selected low-risk patients following blunt trauma?

Article chosen
Hoffman JR, Mower WR, Wolfson AB, Todd KH, Zucker MI. Validity of a set of clinical criteria to rule out injury to the cervical spine in patients with blunt trauma. National Emergency X-Radiography Utilization Study Group. N Engl J Med 2000;343(2):94-9.

Objective
To validate the hypothesis that blunt trauma patients who do not demonstrate any of 5 simple criteria have such a low probability of C-spine injury that imaging studies are unnecessary.

Background
Because physicians recognize the potential morbidity and medicolegal consequences of missed C-spine injuries, approximately 800,000 C-spine radiographs are ordered annually on blunt trauma patients in the US. An overwhelming majority of these are normal. A clinical decision tool that safely identifies patients who do not need x-rays could save money and decrease unnecessary exposure to ionizing radiation. Previous studies suggest that 100% of patients with C-spine injury have at least one of the 5 criteria listed below.

Population studied
All blunt trauma patients who underwent C-spine radiography in participating emergency departments (EDs) were eligible. Exclusion criteria included penetrating trauma, C-spine imaging unrelated to trauma, and those patients for whom the doctor decided C-spine radiographs were unnecessary. Follow-up was a review of the neurosurgical records and quality assurance logs at each site 3 months after completion of the study, looking for missed injuries.

Clinical criteria
To be considered "no risk" for a clinically significant neck injury, patients had to have met all 5 of the following criteria: 1) no midline C-spine tenderness, 2) no focal neurologic deficit, 3) normal level of alertness, 4) no evidence of intoxication and 5) no painful distracting injury.

Study design
Twenty-one US centres, from medical centres to community hospitals, were recruited for this prospective, observational study. A liaison physician from each site attended a 1-hour training session where the study design was presented and the 5 criteria explained. The liaison physician and radiologist from each site were responsible for training and supervising their personnel and collecting patient data.

In eligible patients, physicians prospectively determined the presence or absence of the 5 predefined criteria. A standard 3-view neck series (anterior–posterior, lateral and odontoid) was performed, plus any additional imaging ordered at the discretion of the ED physician. The results of the criteria assessment were then compared to x-ray outcomes to determine the sensitivity and specificity of the criteria.

Radiographic outcomes
Patients were stratified into normal, clinically significant injury, and clinically insignificant injury, based on the radiological interpretation. Prior to the study, the following 8 injuries were defined as clinically insignificant: 1) spinous process fracture, 2) wedge-compression fracture with <25% loss of body height, 3) isolated avulsion without ligamentous injury, 4) type I odontoid fracture, 5) end-plate fracture, 6) osteophyte fracture, 7) transverse process fracture or 8) injury to trabecular bone.

At least 737 patients with a clinically significant C-spine injury were required to estimate the sensitivity of the decision instrument to within 0.5%. The investigators agreed to terminate the study if the decision instrument failed to identify 5 patients with clinically significant injuries.

Results

The study sample included 34,069 patients, 818 with radiographic C-spine injuries. Overall, 29,760 (87.4%) had at least 1 positive clinical criterion. Of these, 810 had a radiographic injury (576 were clinically significant). Among 4,309 patients who had none of the 5 clinical criteria there were 8 radiologic injuries, but only 2 were clinically significant.

The decision instrument was 99.0% sensitive (95% confidence interval [CI], 98%–99.6%) and 12.9% specific (95% CI, 12.8%–13.0%) for radiographic injury. More important, it was 99.6% sensitive (95% CI, 98.6%–100%) and 12.9% specific (95% CI, 12.8%–13.0%) for clinically significant injury. Application of the decision instrument would have spared 12.6% of the patients from receiving C-spine radiography.

Study conclusions

This 5-criterion clinical decision instrument has now been prospectively validated. Its sensitivity for identifying blunt trauma patients who require C-spine radiography approaches 100%.

Commentary

The success of the Ottawa Ankle Rules and the continued emphasis on evidence-based medicine has researchers working hard to develop valid, clinician-friendly decision instruments to guide busy physicians. This well designed multicentre study by the National Emergency X-Radiography Utilization Study (NEXUS) Group is one of several recently published or in development. Of note, a Canadian C-spine decision tool has also been developed and should soon hit the press.

The NEXUS decision tool appears to be safe, in that it identified 99.6% of clinically significant C-spine injuries. Of interest, however, the investigators chose to study implicit (subjective) criteria rather than explicit (precisely defined) criteria. They argue that precise definitions for parameters such as "distracting injury" or "intoxication" are impossible and that if definitions require complex explanation, the decision instrument will not be used. The problem here is that implicit criteria may be interpreted differently by different observers. For example, 2 physicians may examine the same patient and come to different conclusions with respect to whether the patient is intoxicated nor not. If this happens, they will also come to different conclusions about whether or not imaging is necessary. If there is a great deal of variability in how different physicians apply the decision instrument, then it is considered unreliable.

Reliability is critical when discussing diagnostic test utility. If a patient's blood is assayed on 2 different analyzers, it is important that both provide the same sodium result. Similarly, if 2 physicians apply the NEXUS criteria to the same patient, it is important they come to the same conclusion regarding the need for imaging. Interobserver agreement is commonly expressed using kappa values. Table 1 shows that interobserver reliability for each NEXUS criterion was good-to-excellent, and that reliability of the decision instrument was considered excellent ($\kappa = 0.73$).[1]

Table 1. Kappa values (κ) in the NEXUS study

Criterion	κ (95% CI)
Posterior midline tenderness	0.77 (0.65–0.89)
Altered neurologic function*	0.58 (0.41–0.74)
Intoxication	0.86 (0.72–0.99)
Painful distracting injury	0.77 (0.64–0.91)
NEXUS decision instrument	0.73 (0.61–0.86)

CI = confidence interval
*"Altered neurologic function" included altered level of consciousness or focal neurologic deficits. Kappa values were presented for combination but not for each component.

Test sensitivity is a critical performance characteristic for clinical decision tools, and most emergency physicians demand 100% sensitivity before they feel comfortable using such an instrument.[2] This may be appropriate to protect against mortality or serious morbidity; however, increasing test sensitivity usually decreases specificity. An x-ray decision tool that is too sensitive (safe) is likely to be nonspecific, and will trigger the use of x-rays for many patients without injury. A nonspecific decision tool has the potential to increase rather than decrease utilization. To limit this problem, the NEXUS group (like the Canadian C-spine investigators) prospectively identified several clinically insignificant injuries that would be "safe" to miss. Despite this, the NEXUS tool was only 12.9% specific, meaning that, of 33,251 patients who did not have radiologic injuries, 28,950 required x-rays based on the NEXUS criteria.

The NEXUS criteria indicated the need for imaging in 87.4% of patients studied. The authors conclude that this represents a 12.6% utilization reduction. It is not clear, however, that this reduction is possible in Canada, where the fear of litigation is less acute and where clinical judgement is more often exercised. To illustrate, a 1997 multicentre study[3] showed that, in patients who presented to Canadian EDs with blunt neck trauma, x-ray rates varied from 37% to 72.5% (mean, 58%) by hospital, and from 15.6% to 91.5% by individual physician. It seems likely that the application of the NEXUS criteria in a Canadian

setting could increase C-spine x-ray utilization for many hospitals and physicians.

The NEXUS C-spine decision instrument is the result of excellent collaborative research. Before adopting this as a Canadian practice standard, however, it should undergo independent validation, both to confirm safety and also to ensure that it does not lead to increased x-ray utilization rates.

References

1. Mahadevan S, Mower WR, Hoffman JR, Peeples N, Goldberg X, Sonner R. Interrater reliability of cervical spine injury criteria in patients with blunt trauma. Ann Emerg Med 1998;31:197-201.
2. Graham ID, Stiell IG, Laupacis A, O'Connor AM, Wells GA. Emergency physicians' attitudes toward and use of clinical decision rules for radiography. Acad Emerg Med 1998;5:134-40.
3. Stiell IG, Wells GA, Vandemheen K, Laupacis A, Brison R, Eisenhauer MA, et al. Variation in emergency department use of cervical spine radiography for alert, stable trauma patients. CMAJ 1997;156:1537-44.

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