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Prevalence of Chest Injury With the Presence of NEXUS Chest Criteria: Data to Inform Shared Decision making About Imaging Use

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Study objective: The NEXUS chest decision instrument identifies a very-low-risk population of patients with blunt trauma for whom chest imaging can be avoided. However, it requires that all 7 National Emergency X-Ray Utilization Study (NEXUS) chest criteria be absent. To inform patient and physician shared decision making about imaging, we describe the test characteristics of individual criteria of the NEXUS chest decision instrument and provide the prevalence of injuries when 1, 2, or 3 of the 7 criteria are present.

Methods: We conducted this secondary analysis of 2 prospectively collected cohorts of patients with blunt trauma who were older than 14 years and enrolled in NEXUS chest studies between December 2009 and January 2012. Physicians at 9 US Level I trauma centers recorded the presence or absence of the 7 NEXUS chest criteria. We calculated test characteristics of each criterion and combinations of criteria for the outcome measures of major clinical injuries and thoracic injury observed on chest imaging.

Results: We enrolled 21,382 patients, of whom 992 (4.6%) had major clinical injuries and 3,135 (14.7%) had thoracic injuries observed on chest imaging. Sensitivities of individual test characteristics ranged from 15% to 56% for major clinical injury and 14% to 53% for thoracic injury observed on chest imaging, with specificities varying from 71% to 84% for major clinical injury and 67% to 84% for thoracic injury observed on chest imaging. Individual criteria were associated with a prevalence of major clinical injury between 1.9% and 3.8% and of thoracic injury observed on chest imaging between 5.3% and 11.5%.

Conclusion: Patients with isolated NEXUS chest criteria have low rates of major clinical injury. The risk of major clinical injury for patients with 2 or 3 factors range from 1.7% to 16.6%, depending on the combination of criteria. Criteria specific risks could be used to inform shared decision making about the need for imaging by patients and their physicians. [Ann Emerg Med. 2016; 68:222-226.]

INTRODUCTION

Editor’s Capsule Summary
What is already known on this topic
The NEXUS blunt chest trauma tool is validated but currently requires absence of all 7 risk variables to omit imaging.

What question this study addressed
How do the individual variables of the NEXUS blunt trauma chest imaging tool perform in assessing injury?

What this study adds to our knowledge
In a retrospective review of 21,382 injured patients from 2 trials, the sensitivities for major injuries of each criterion varied between 14% and 56%. The risk of major clinical injury for patients with 2 or 3 factors ranged from 1.7% to 16.6%.
How this is relevant to clinical practice
Grouped but incomplete NEXUS blunt chest trauma prediction data can inform the likelihood of injury but retain risk of missed injury.

Background
An estimated 22.4 million visits are made to US emergency departments (EDs) each year for injury-related conditions, and the use of computed tomography (CT) or magnetic resonance imaging during these visits has increased from 6% in 1998 to 15% in 2007.1 This increase in imaging has not been accompanied by a proportional increase in the diagnosis of life threatening conditions,1 but has led to longer ED stays, higher costs, and increased ionizing radiation exposure.2-6

Patient preference for CT imaging varies and depends on the potential for serious injury.7 However, these potential risks are either poorly quantified or completely unknown, limiting the extent to which outcome data can inform patient and physician shared decision making about imaging. Physicians and patients need tools and data that provide accurate assessments of individual risks for significant clinical injury.7

Importance
The National Emergency X-Ray Utilization Study (NEXUS) chest decision instrument was derived and validated to decrease unnecessary thoracic imaging in patients with blunt trauma and has 99.7% sensitivity and 99.9% negative predictive value for excluding major thoracic injury observed on chest imaging.8 The absence of all 7 of the NEXUS chest clinical criteria (aged >60 years, rapid deceleration mechanism, chest pain, intoxication, abnormal alertness/mental status, distracting painful injury, and tenderness to chest wall palpation) defines a patient population that is at very low risk for major thoracic injury. However, the specificity of the NEXUS chest decision instrument was 13.3%; thus, the majority of patients will not meet all 7 criteria and therefore cannot be ruled out for injury.

MATERIALS AND METHODS

Study Design and Setting
This study was a planned secondary analysis of 2 prospectively collected multicenter data sets of patients with blunt trauma who presented to 9 US Level I trauma centers between December 2009 and January 2012. These studies had identical enrollment criteria, in which patients with blunt trauma who were older than 14 years and received chest imaging (chest radiograph or CT) were enrolled with a systematic sampling method between 7 AM and 11 PM daily. Physicians caring for enrolled subjects received no guidance or recommendations by the study team for imaging decisions. Detailed descriptions of the study methodology are available elsewhere.8-10

Methods of Measurement and Outcome Measures
Before viewing radiographic results, physicians recorded the presence or absence of the 7 NEXUS chest clinical criteria (aged >60 years, rapid deceleration mechanism, chest pain, intoxication, abnormal alertness/mental status, distracting painful injury, and tenderness to chest wall palpation). All 7 of the clinical criteria had interrater reliability (k) values greater than 0.6. We determined the presence of thoracic injury observed on chest imaging (pneumothorax, hemothorax, aortic or great vessel injury, 2 or more rib fractures, ruptured diaphragm, sternal fracture, and pulmonary contusion or laceration) by radiologic reports, and of major clinical injury by following enrolled subjects to determine whether they were admitted to the hospital and had clinical interventions (as defined a priori by an expert panel). Investigators categorizing outcomes were not blinded to the presence or absence of clinical criteria. We calculated screening performance characteristics of NEXUS chest decision instrument criteria and the prevalence of injury when 1, 2, or 3 criteria were present.
RESULTS

Of the 9,905 patients enrolled in the first NEXUS chest validation study cohort, 363 (3.7%) had major clinical injury and 1,478 (14.9%) had thoracic injury observed on chest imaging. Of the 11,477 patients enrolled in the second NEXUS chest study cohort, 629 (5.5%) had major clinical injury and 1,657 (14.4%) had thoracic injury observed on chest imaging. For this analysis, we combined the data sets for a total of 21,382 patients, of whom 992 (4.6%) had major clinical injuries and 3,135 (14.7%) had thoracic injuries observed on chest imaging.

Table 1 provides the screening performance characteristics of the individual criteria. Overall, distracting injury, chest wall tenderness, chest pain, and rapid deceleration were most sensitive in detecting major clinical injury (56%, 53%, 52%, and 49%, respectively). These criteria had similar test characteristics for thoracic injury observed on chest imaging. Chest wall tenderness and chest pain had positive likelihood ratios greater than 2.0.

Table 2 provides the prevalence of major clinical injury and thoracic injury observed on chest imaging for all single criteria, as well as all pairs and trios of criteria exhibited by least 100 patients. Single-criteria prevalences of major clinical injury ranged from 1.9% to 3.8%, and prevalences of thoracic injury observed on chest imaging ranged from 5.3% to 11.5%. Similarly, criteria pairs had ranges of major clinical injury prevalence from 1.7% to 9.5% and of thoracic injury observed on chest imaging prevalence from 4.5% to 29.1%, and trios had ranges of major clinical injury prevalence from 1.7% to 16.6% and of thoracic injury observed on chest imaging from 8.4% to 40%.

LIMITATIONS

As a secondary analysis of 2 previously collected databases, data acquisition and other limitations of the original studies carry over to this work and our definitions of thoracic injury observed on chest imaging versus major clinical injury. Our results may not apply outside of the large academic Level I trauma centers engaged in the study. Readers may also disagree with our definitions of thoracic injury observed on chest imaging and major clinical injury. These were developed by an expert panel and may not be generalizable to other physicians or patients.

Given that the numbers of patients with certain combinations of criteria in our study were low and the number of patients with injury even lower, the point estimates of injury prevalence for particular factors may be imprecise and exhibit substantial potential for variability.

DISCUSSION

A recent study found that patients’ preferences for CT imaging after blunt trauma decrease with the risk of injury; where as 91% of patients preferred to have a CT if the risk of life-threatening imaging was 25%, this decreased to 79% at a risk of 10%, 69% at a risk of 5%, and 54% with a risk less than 2%. At a risk of 2% (and with a $1,000 out-of-pocket cost), preference for CT decreased even further, to 35%. Given that
the risks of injury found in this current study varied from 1.7% to 40%, the results from the earlier study support our belief that data in regard to prevalence of injury may affect patient and physician imaging decisions.

When none of the 7 criteria are present, the NEXUS chest decision instrument effectively rules out thoracic injury observed on chest imaging. However, its specificity is low—13.3% in the validation study—and consequently many uninjured patients will exhibit at least 1 of the 7 criteria. Aggressive adherence to the rule would subject these patients to imaging despite low probabilities of injury. Our findings in this analysis provide information on the injury risk associated with individual patient presentations and can help inform both patients and their physicians on the benefits and risks related to imaging decisions. This information may enhance shared decision making and allow choices to be based on an individual patient’s preferences and specific risk tolerance.

Our data demonstrated that the lowest prevalences of major clinical injury and thoracic injury observed on chest imaging for patients with single criteria were in those who were intoxicated or had altered mental status. Conversely, patients who met the criteria of distracting injury, chest pain, or chest wall tenderness were more likely to have injury. We anticipate physicians would reference Table 2—perhaps made more easily available in a computerized decision support system—before having conversations about imaging with their patients with blunt trauma.

We envision these data being used in physicians’ discussions with patients who have sustained blunt trauma and who have 1, 2, or 3 of the NEXUS chest criteria present, allowing data-informed, individualized, and shared decision making about thoracic imaging to become the norm. For example, a patient with blunt trauma who has a rapid deceleration mechanism might opt, once he or she learns from a physician that the risk of major clinical injury is 2.7%, to forgo chest imaging. Another patient, older than...
60 years and with a rapid deceleration mechanism and a distracting injury, may more readily consent to chest imaging on learning that the risk of major clinical injury is 16.6%. These imaging decisions could then be informed joint decisions between patients and providers, taking into account the risk tolerances and imaging preferences of both. Some of the NEXUS chest risk factors (altered mental status, intoxication, and perhaps distracting injury, depending on its severity) may preclude shared decision making when present.

Patients with isolated NEXUS chest criteria have low rates of major clinical injury. The risk for patients with 2 or 3 factors ranges from 1.7% to 16.6%, depending on the combination of criteria. Criteria-specific risks could be used to inform shared decision making in regard to the need for imaging by patients and their physicians.

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