Is Chest Ultrasonography Superior to Supine Chest Radiography in Identifying Pneumothorax in Emergency Department Trauma Patients?

TAKE-HOME MESSAGE

Chest ultrasonography performed by trained emergency physicians is more sensitive than supine chest radiography in assessing emergency department trauma patients for pneumothorax.

METHODS

DATA SOURCES

Two authors searched the Cochrane Database of Systematic Reviews, Cochrane Central Register of Controlled Trials, EMBASE, Web of Science Core Collection, MEDLINE, Cumulative Index of Nursing and Allied Health Literature Plus, Database of Abstracts of Reviews of Effects, and ClinicalTrials.gov up to April 10, 2020, using a combination of terms including "chest radiography," "ultrasound," and "pneumothorax." The authors also evaluated reference lists of identified publications and performed forward-citation searching of relevant articles in Google Scholar and PubMed. There were no language restrictions.

STUDY SELECTION

Authors included prospective, paired, comparative accuracy studies for trauma patients with suspected pneumothorax irrespective of age or sex. Patients must have received chest ultrasonography by a frontline, nonradiologist physician and chest radiography as index tests, both in the supine position, with computed

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Editor's Note: This is a clinical synopsis, a regular feature of the *Annals'* Systematic Review Snapshot (SRS) series. The source for this systematic review snapshot is: **Chan K, Joo DA, McRae AD, et al. Chest ultrasonography versus supine chest radiograph for diagnosis of pneumothorax in trauma patients in the emergency department. *Cochrane Database Syst Rev.*** https://doi.org/10.1002/14651858.CD013031.pub2**.**

Results

Diagnostic accuracy of chest ultrasonography and chest radiography for traumatic pneumothorax.

Test	No. of Studies (No. of Patients)	Sensitivity (95% CI)	Specificity (95% CI)
CUS	9 (1,271)	0.91 (0.85–0.94)	0.99 (0.97–1.00)
CXR	9 (1,271)	0.47 (0.31–0.63)	1.00 (0.97–1.00)

CUS, Chest ultrasonography; *CXR*, chest radiography.

Authors included 9 studies comprising 1,271 patients with 410 pneumothoraces from an initial 2,293 references. The median prevalence of traumatic pneumothorax was 30% (range 21% to 52%). Two studies used a linear probe, 2 used a curvilinear probe, and the remaining 5 used either a linear or curvilinear probe. The overall sensitivity of chest ultrasonography was 0.91 (95% confidence interval [CI] 0.85 to 0.94) and the specificity was 0.99 (95% CI 0.97 to 1.00) (Table). Comparatively, the sensitivity of chest radiography was 0.47 (95% CI 0.31 to 0.63) and the specificity was 1.00 (95% CI 0.97 to 1.00). Subgroup analysis demonstrated the sensitivity and specificity of emergency

tomography (CT) of the chest or tube thoracostomy for the criterion standard. Two authors independently assessed studies for relevance and resolved disagreements through discussion, arbitrated by a third author.

DATA EXTRACTION AND SYNTHESIS

Two investigators independently extracted data from included studies, with discrepancies resolved by a third author. The primary outcome was the diagnostic accuracy of chest ultrasonography versus chest radiography for the diagnosis of pneumothorax in ED trauma patients.[1] Subgroup analyses were stratified by type of trauma (blunt versus blunt and penetrating), type of chest ultrasonographic operator, and type of transducer. The authors also performed a sensitivity analysis assessing only studies that blinded outcome assessors evaluating the results of chest ultrasonography to the results of chest radiography and vice versa. Investigators performed this meta-analysis on binary data, using a bivariate meta-regression to estimate sensitivity and specificity. Investigators assessed heterogeneity with forest plots and summary receiver operating characteristic plots. Two investigators assessed risk of bias and applicability of each study according to the Quality Assessment of Diagnostic Accuracy Studies–2 tool.[2]

physicians (8 studies, 1,192 patients) with chest ultrasonography to be 0.91 (95% CI 0.85 to 0.95) and 0.99 (95% CI 0.97 to 1.00), respectively, whereas trauma surgeons (1 study, 79 patients) had a sensitivity and specificity of 0.82 (95% CI 0.60 to 0.95) and 1.00 (95% CI 0.94 to 1.00), respectively. When studies in which the outcome assessor was not blinded to the alternate test results were excluded, the sensitivity was 0.92 (95% CI 0.85 to 0.96) and the specificity was 0.99 (95% CI 0.97 to 1.00).

Commentary

Traumatic pneumothoraces are the result of introduction of air into the pleural space from a blunt or penetrating mechanism and occur at an annual incidence of 81 per 100,000 people.[3] If pneumothoraces go unrecognized and patients receive positive pressure, tension physiology and ventilation/perfusion mismatch may develop and result in cardiopulmonary arrest.[3,4] Thus, early identification during initial trauma resuscitation plays a crucial role in rapid intervention. This can be diagnosed by chest ultrasonography or chest radiography. The individual sonographic findings on chest ultrasonography include absence of lung sliding, absence of comet-tail artifacts, presence of a lung point, or the absence of a lung pulse. Although the Advanced Trauma Life Support guidelines recommend chest radiography as an adjunct to the primary survey, literature has suggested that this is not a sensitive test for pneumothorax.[5,6]

This review is the most comprehensive meta-analysis to date comparing chest ultrasonography and chest radiography for diagnosis of pneumothorax in ED trauma patients. The authors of this review found superior sensitivities for chest ultrasonography compared with supine chest radiography in ED trauma patients.[7]

However, there are several limitations that must be considered for this Cochrane review. First, ultrasonography is an operator-dependent skill and is predicated on sufficient training and practice. Although most studies evaluated chest ultrasonography performed by emergency physicians among trauma patients, there were differences in experience, training, and specific patient populations. The median prevalence of pneumothorax within these studies was 30%, which likely surpasses the median prevalence of traumatic pneumothoraces compared with that in an average practice environment. Additionally, several studies did not describe whether M mode or B mode was used for the chest ultrasonographic assessments. The use of lung pulse and lung point also varied between studies. It is unclear whether the operators were blinded to the outcome of other tests and interventions, which may have biased their results. With 2 different verification methods used as a criterion standard, CT or tube thoracostomy, the authors may have introduced differences in identification accuracy (ie, differential verification bias). It was also unclear in several studies whether patients were enrolled consecutively or as a convenience sample, with the latter increasing the risk of selection bias. Studies excluded patients for whom ultrasonography was contraindicated (eg, hemodynamically unstable patients, those with chest wall injuries), so the diagnostic

accuracy in these patients remains unclear. Although authors acquired sensitivity and specificity data comparing emergency physicians with surgeons, a single study comparing these 2 operator groups is not sufficient to comment on their comparative abilities. Moreover, the data did not assess accuracy stratified by the size of the pneumothorax or by clinical relevance (ie, need for tube thoracostomy or admission). Finally, several studies did not adequately describe the timing difference between the index test (ie, chest ultrasonography or chest radiography) and CT, which may have favored the accuracy in one group if it was performed later in the course after CT.

According to these results, chest ultrasonography appears more sensitive than supine chest radiography in detecting traumatic pneumothoraces. Given the portable, noninvasive, rapid nature of this bedside imaging modality, chest ultrasonography should be used for the initial evaluation of suspected pneumothoraces in the ED setting. As with all ultrasonographic examinations, it is important to ensure adequate training, given the operator-dependent nature of this skill set.

The view(s) expressed herein are those of the author(s) and do not reflect the official policy or position of Brooke Army Medical Center, the US Army Medical Department, the US Army Office of the Surgeon General, the Department of the Army, the Department of the Air Force and Department of Defense, or the US government.

Dr. Carlson was the supervising editor on this article. Dr. Gottlieb did not participate in the editorial review or decision to publish this article.

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