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Review Article

Diagnostic Accuracy of Point-of-Care Ultrasound Versus Chest X-Ray for Pneumothorax Detection in Supine Blunt Trauma Patients

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ABSTRACT

Background: Traumatic pneumothorax requires rapid recognition during blunt-trauma resuscitation, yet portable supine chest radiography (CXR) has limited sensitivity because intrapleural air may accumulate anteriorly and remain radiographically occult. Point-of-care ultrasound (POCUS) provides rapid bedside assessment without ionizing radiation, but its comparative diagnostic performance in supine blunt-trauma patients requires focused synthesis. Objective: To systematically review and meta-analyze the diagnostic accuracy of bedside POCUS compared with portable supine CXR for detecting traumatic pneumothorax, using thoracic computed tomography as the principal reference standard. Methods: PubMed/MEDLINE, Embase, Scopus, Web of Science, and the Cochrane Library were systematically searched for diagnostic studies evaluating POCUS and supine CXR in blunt-trauma populations. Eligible studies provided diagnostic accuracy data against an appropriate reference standard. Study selection and data extraction were performed independently by two reviewers. Methodological quality was assessed using diagnostic-accuracy risk-of-bias principles based on QUADAS-2. Sensitivity and specificity were synthesized using a bivariate random-effects diagnostic meta-analysis, with heterogeneity and clinically relevant subgroup differences evaluated where data permitted. Results: Eleven studies comprising 2,839 participants were included. POCUS demonstrated pooled sensitivity of 87.3% (95% CI 84.2–90.0%; I^2=41.2%), compared with 48.2% (95% CI 44.1–52.3%; I^2=28.4%) for supine CXR. Pooled specificity was 98.2% (95% CI 97.3–98.9%) for POCUS and 99.0% (95% CI 98.3–99.5%) for CXR. POCUS detected 79.4% (95% CI 72.8–84.8%) of CT-confirmed radiographically occult pneumothoraxes. Conclusion: POCUS provides substantially greater sensitivity than supine CXR for detecting traumatic pneumothorax while maintaining similarly high specificity. Thoracic POCUS is therefore a valuable early bedside diagnostic modality, although confirmatory imaging remains appropriate when findings are negative, indeterminate, or clinically discordant. Keywords: Ultrasonography; Pneumothorax; Radiography, Thoracic; Wounds, Nonpenetrating; Sensitivity and Specificity; Point-of-Care Systems; Meta-Analysis.

INTRODUCTION

Thoracic injury is a major contributor to preventable morbidity and mortality after blunt trauma, and traumatic pneumothorax represents an important immediately treatable complication because delayed recognition may result in progressive respiratory compromise or tension physiology during resuscitation (1). Early diagnosis can be particularly difficult in patients who must remain supine because of spinal precautions, altered consciousness, hemodynamic instability, or multiple injuries. Portable anteroposterior chest radiography (CXR) remains widely incorporated into initial trauma assessment; however, the supine position alters the distribution of intrapleural air, allowing small or anterior pneumothoraces to remain radiographically occult (2,3). Computed tomography (CT) provides substantially greater anatomic sensitivity and is generally regarded as the reference standard for detecting occult traumatic pneumothorax, but immediate CT may be impractical in unstable patients because it requires transfer away from the resuscitation area, exposes patients to ionizing radiation, and may delay time-sensitive treatment (1,3).

Point-of-care ultrasound (POCUS), particularly when incorporated into the extended Focused Assessment with Sonography for Trauma examination, offers an alternative bedside approach that can be performed rapidly and repeatedly without radiation exposure. Pneumothorax can be identified sonographically through combinations of findings such as absent pleural sliding, absence of B-lines, abnormal M-mode patterns, and visualization of the lung point. Previous systematic reviews and diagnostic studies have generally demonstrated substantially greater sensitivity of thoracic ultrasonography than supine chest radiography while maintaining high specificity for pneumothorax detection (2–5). Contemporary comparative studies have further supported the potential diagnostic advantage of bedside ultrasound during acute trauma assessment, particularly for pneumothoraces that are not visible on initial supine radiographs (4,6–8). Nevertheless, the reported accuracy of POCUS has not been uniform across studies. Differences in operator experience, ultrasound training, transducer selection, scanning zones, diagnostic criteria, patient habitus, subcutaneous emphysema, underlying pulmonary disease, pneumothorax size, and reference-standard verification may all influence diagnostic performance (5–8).

Despite an established body of literature supporting thoracic ultrasonography, an important evidence gap remains regarding its comparative performance specifically in supine patients with blunt trauma. Earlier diagnostic reviews have frequently included heterogeneous emergency populations, different mechanisms of pneumothorax, variable patient positioning, or studies in which ultrasound and chest radiography were not evaluated within a narrowly defined blunt-trauma diagnostic pathway (2,3,5). These differences can limit direct application of pooled estimates to patients undergoing non-upright trauma resuscitation, in whom the limitations of conventional radiography are most clinically relevant. Moreover, increasingly routine incorporation of POCUS into emergency and trauma practice, together with evolving ultrasound technology and operator training, provides a rationale for reassessing the contemporary evidence base (4,6–8). A focused comparative synthesis is therefore needed not merely to establish whether thoracic ultrasound can detect pneumothorax, but to determine the magnitude and consistency of its diagnostic advantage over portable supine CXR when both are evaluated against an appropriate reference standard. Such evidence can better inform the intended role of POCUS within initial diagnostic pathways while recognizing that diagnostic accuracy alone does not establish improved patient outcomes or justify replacement of other imaging modalities in every clinical circumstance.

Accordingly, this systematic review and diagnostic test accuracy meta-analysis was undertaken to determine, among adult and pediatric patients with blunt trauma undergoing evaluation in the supine position, how accurately bedside POCUS detects traumatic pneumothorax compared with portable supine CXR when thoracic CT is used as the principal reference standard. The primary objective was to compare pooled sensitivity and specificity between the two modalities, with additional evaluation of likelihood ratios, diagnostic odds ratios, between-study heterogeneity, and clinically relevant sources of variation where adequately reported. The review question was therefore: among supine blunt trauma patients undergoing emergency evaluation, does bedside POCUS provide greater diagnostic sensitivity than portable supine CXR for traumatic pneumothorax while maintaining comparable specificity against CT-based confirmation?

MATERIALS AND METHODS

This systematic review and diagnostic test accuracy meta-analysis was designed to compare the performance of point-of-care ultrasound (POCUS) with portable supine chest radiography (CXR) for detecting traumatic pneumothorax in patients with blunt trauma. The review was conducted and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses of Diagnostic Test Accuracy Studies (PRISMA-DTA) and the PRISMA 2020 statement (9,10). The methodological approach was structured around the diagnostic review question defined by the target population, index test, comparator test, target condition, and reference standard, with emphasis on comparative sensitivity and specificity rather than therapeutic effectiveness.

Eligible studies enrolled adult or pediatric patients presenting with blunt trauma who underwent diagnostic assessment for pneumothorax while supine in an emergency department, trauma resuscitation unit, or comparable acute-care setting. Bedside thoracic POCUS or an extended Focused Assessment with Sonography for Trauma examination constituted the index test, whereas portable supine anteroposterior CXR constituted the comparator test. The target condition was traumatic pneumothorax, including pneumothoraces not visible on the initial supine radiograph. Thoracic computed tomography was considered the principal reference standard. Studies in which urgent pleural decompression preceded CT assessment were eligible when the definitive clinical reference procedure provided direct confirmation of pneumothorax. Eligible designs included prospective and retrospective diagnostic cohort studies, cross-sectional diagnostic accuracy studies, and clinical studies in which POCUS and supine CXR could be evaluated against an appropriate reference standard. Studies were excluded when they evaluated spontaneous or other non-traumatic pneumothorax exclusively, enrolled only upright patients, lacked an appropriate reference standard, did not permit extraction of diagnostic accuracy data, consisted of case reports or case series with fewer than 10 participants, were conference abstracts without sufficient methodological information, represented non-peer-reviewed grey literature, or were published in languages other than English.

A systematic literature search was undertaken in PubMed/MEDLINE, Embase, Scopus, Web of Science, and the Cochrane Library. Search concepts represented four principal domains: bedside ultrasonography, chest radiography, pneumothorax, and blunt thoracic trauma. Controlled vocabulary and free-text terminology were combined where supported by the individual database. The core PubMed search concept combined terms for point-of-care ultrasound, POCUS, thoracic ultrasonography, and eFAST with terms for chest radiography, chest X-ray, and supine radiography, together with pneumothorax, occult pneumothorax, blunt trauma, and thoracic injury. Boolean operators were used to combine synonymous terms with “OR” and the principal diagnostic concepts with “AND.” Bibliographies of relevant systematic reviews and eligible primary studies were additionally examined to identify potentially eligible reports that had not been captured through the electronic database search.

Retrieved records were consolidated and duplicate citations were removed before screening. Study selection was undertaken in two sequential stages by two reviewers working independently. Titles and abstracts were first assessed against the predefined eligibility criteria, after which potentially relevant reports underwent full-text evaluation. Studies were retained for quantitative synthesis only when the population, index and comparator tests, reference standard, and diagnostic outcomes were compatible with the review question and sufficient information was available to derive or extract diagnostic contingency data. Disagreements at either screening stage were resolved through discussion and consensus; unresolved disagreements were adjudicated by a third reviewer. Reasons for exclusion at the full-text stage were classified according to the principal eligibility criterion not fulfilled, and the overall study-selection process was documented using a PRISMA flow diagram (9,10).

Data were extracted independently using a standardized data-collection framework developed for the review. Extracted study-level information included first author, publication year, country, clinical setting, study design, sample size, participant age and sex distribution, mechanism of injury, pneumothorax prevalence, patient positioning, POCUS protocol, transducer type where reported, thoracic scanning zones, sonographic diagnostic criteria, operator experience, CXR protocol, reference standard, and timing of the index, comparator, and reference tests. Diagnostic outcome data were extracted preferentially as true-positive, false-positive, true-negative, and false-negative counts for each modality. When explicitly reported, sensitivity, specificity, positive and negative predictive values, positive and negative likelihood ratios, and diagnostic odds ratios were also recorded. Particular attention was paid to whether diagnostic observations were reported at the patient or hemithorax level so that statistically non-equivalent units were not combined within the same pooled analysis. Data describing radiographically occult pneumothorax were extracted separately when these cases were confirmed by the reference standard.

Methodological quality was assessed using the Quality Assessment of Diagnostic Accuracy Studies framework, with evaluation centered on patient selection, conduct and interpretation of the index test, conduct and interpretation of the reference standard, and participant flow and timing. Risk-of-bias judgments considered whether recruitment methods could introduce spectrum or selection bias, whether interpretation of POCUS and CXR was independent of the reference-standard result, whether the reference standard was applied consistently, whether clinically important delays occurred between diagnostic assessments, and whether all enrolled participants were included in the analysis. Applicability concerns were considered in relation to the target blunt-trauma population, bedside ultrasound technique, radiographic procedure, and definition of pneumothorax. Because the principal review outcomes were diagnostic accuracy estimates rather than treatment effects, methodological appraisal was applied according to diagnostic-test-accuracy principles irrespective of whether an individual report was described as prospective, retrospective, observational, or randomized.

Study characteristics, clinical protocols, operator factors, and methodological differences were first summarized narratively to determine whether quantitative pooling was appropriate. Meta-analysis was undertaken when studies provided sufficiently comparable data for POCUS and/or supine CXR against the specified reference standard. Sensitivity and specificity were treated as the principal diagnostic accuracy measures. Because these measures are statistically related and may vary jointly across studies, pooled estimates were obtained using a bivariate random-effects diagnostic meta-analytic framework rather than independent univariate pooling alone. Summary estimates were expressed with 95% confidence intervals. Positive and negative likelihood ratios and diagnostic odds ratios were synthesized as secondary measures where adequate data were available, and the overall relationship between sensitivity and specificity was evaluated using summary receiver operating characteristic analysis.

Comparative interpretation focused on differences in diagnostic sensitivity between POCUS and supine CXR while simultaneously considering specificity, because an apparent improvement in sensitivity should not be interpreted independently of potential changes in false-positive classification. Where both modalities were evaluated in the same study population against the same reference standard, comparative findings were interpreted as paired diagnostic evidence rather than as results from unrelated patient groups. The absolute difference in pooled sensitivity was used to describe the magnitude of the principal diagnostic contrast when supported by the synthesized estimates. Radiographically occult pneumothoraces were evaluated separately to determine the proportion of CT-confirmed cases not detected by initial supine CXR that were identified by POCUS.

Between-study heterogeneity was evaluated clinically and statistically. Clinical sources of heterogeneity considered differences in participant characteristics, pneumothorax prevalence and extent, operator expertise, transducer selection, thoracic scanning protocol, diagnostic criteria, reference-standard application, and study design. Statistical heterogeneity was assessed using Cochran's Q and the I^2 statistic as supplementary measures alongside inspection of variation in individual diagnostic estimates. Because diagnostic accuracy can be influenced by operator proficiency, subgroup analysis examined POCUS performance according to reported operator experience when sufficient study-level information was available. Differences in diagnostic performance across such subgroups were interpreted cautiously because subgroup comparisons were observational and potentially confounded by differences in study populations, training protocols, equipment, and scanning techniques.

All analyses were interpreted in the context of methodological quality, clinical heterogeneity, and the applicability of the included evidence to supine blunt-trauma resuscitation. Diagnostic accuracy was not equated with improved patient outcomes, and pooled estimates were interpreted as measures of test performance rather than evidence that either imaging strategy independently reduces morbidity, mortality, time to intervention, or resource utilization.

RESULTS

The systematic search identified 104 records across the five electronic databases. After removal of 21 duplicate records, 83 unique records underwent title and abstract screening. Fifty-five records were excluded at this stage because they did not satisfy the predefined population, positioning, diagnostic-comparison, or study-design criteria, leaving 28 reports for full-text assessment. Seventeen full-text articles were excluded: seven included mixed or predominantly upright patient positioning, five did not use an eligible CT-based or definitive clinical reference standard, three evaluated non-traumatic pneumothorax, and two did not provide sufficient diagnostic contingency data for quantitative synthesis. Eleven studies consequently met the eligibility criteria and were included in the qualitative and quantitative synthesis.

The 11 included studies comprised nine prospective observational cohort studies, one retrospective cohort study, and one prospective diagnostic trial. Based on the individual sample sizes reported in the study-characteristics dataset, the evidence base included comprised 2,839 participants. Individual study sample sizes ranged from 112 to 482 participants. Reported mean or median ages ranged from 34.2 to 46.8 years, and the proportion of male participants ranged from 68.4% to 76.2%. Motor-vehicle collisions and falls from height were the predominant mechanisms of blunt injury. POCUS protocols generally evaluated anterior and lateral thoracic regions for sonographic findings associated with pneumothorax, including loss of lung sliding, absence of B-lines, and identification of a lung point. Supine anteroposterior CXR was performed during initial trauma evaluation, and thoracic CT served as the principal diagnostic reference standard in the included-study summary. Study characteristics and modality-specific diagnostic findings are presented in Table 1.

Table 1. Characteristics and diagnostic findings of included studies evaluating POCUS versus supine CXR for traumatic pneumothorax

Study	Country	Design	N	Age, years	Male, %	POCUS sensitivity, %	POCUS specifically, %	CXR sensitivity, %	CXR specificity, %
Ince et al. (2023)	Turkey	Prospective cohort	210	41.5	71.4	89.2	98.6	48.6	99.3
Gibbons et al. (2023)	USA	Prospective cohort	315	44.1	68.6	88.1	97.8	51.2	98.9
Kumar et al. (2023)	India	Prospective cohort	172	38.6	74.4	82.6	100.0	43.5	99.0
Bober et al. (2022)	USA	Retrospective cohort	482	46.8	70.1	85.4	98.2	47.1	99.1
Staub et al. (2022)	Brazil	Prospective cohort	260	39.8	76.2	91.3	96.9	52.2	98.5
Alrajhi et al. (2021)	Canada	Prospective cohort	304	42.3	72.0	87.5	98.1	49.0	99.5
Tran et al. (2024)	USA	Prospective cohort	225	45.2	69.8	86.7	98.5	44.4	99.1
Ranganath et al. (2026)	India	Prospective diagnostic trial	180	36.4	75.0	84.8	99.1	41.3	98.9
Zhao et al. (2021)	China	Prospective cohort	195	40.1	73.8	90.0	97.4	53.3	98.7
Patel et al. (2020)	UK	Prospective cohort	384	43.7	68.4	86.1	98.8	46.5	99.2
Martinez et al. (2020)	Spain	Prospective cohort	112	34.2	71.4	92.3	96.5	53.8	98.8
Total	–	–	2,839	–	–	–	–	–	–

POCUS, point-of-care ultrasound; CXR, chest radiography; CT, computed tomography.

Methodological appraisal demonstrated variation across the principal diagnostic-accuracy domains rather than uniformly low risk of bias. Nine of 11 studies (81.8%) were judged to have low risk of bias for patient selection, 10 of 11 (90.9%) for conduct or interpretation of the index test, eight of 11 (72.7%) for the reference-standard domain, and nine of 11 (81.8%) for flow and timing. The most frequent concerns were convenience-based recruitment during selected clinical shifts and incomplete or selective CT verification in clinically defined subgroups, both of which could influence the estimated diagnostic performance. Domain-level findings are summarized in Table 2.

Table 2. Summary of risk-of-bias assessment across included diagnostic studies

Diagnostic-accuracy domain	Studies judged low risk, n/N	Low risk, %	Principal concern identified
Patient selection	9/11	81.8	Convenience or shift-dependent recruitment
Index test	10/11	90.9	Potential variation in operator expertise or interpretation
Reference standard	8/11	72.7	Selective or partial CT verification
Flow and timing	9/11	81.8	Differential verification or incomplete diagnostic pathways

Quantitative synthesis demonstrated a marked difference in pooled sensitivity between the two diagnostic modalities. POCUS yielded a pooled sensitivity of 87.3% (95% CI 84.2%–90.0%; I^2=41.2%), compared with 48.2% (95% CI 44.1%–52.3%; I^2=28.4%) for supine CXR. The absolute difference in pooled sensitivity was 39.1 percentage points, with the reported between-modality comparison indicating $p<0.001$. In contrast, pooled specificity was high for both modalities: 98.2% (95% CI 97.3%–98.9%) for POCUS and 99.0% (95% CI 98.3%–99.5%) for supine CXR, with no statistically significant between-modality difference ($p=0.18$).

POCUS also demonstrated a pooled positive likelihood ratio of 48.5 (95% CI 32.1–73.2), a negative likelihood ratio of 0.13 (95% CI 0.10–0.17), and a diagnostic odds ratio of 373.1 (95% CI 210–662). Corresponding estimates for supine CXR were 48.2 (95% CI 28.4–81.8), 0.52 (95% CI 0.48–0.57), and 92.7 (95% CI 52.1–164), respectively. The markedly lower negative likelihood ratio for POCUS was consistent with its substantially greater sensitivity, whereas the similar positive likelihood ratios reflected the very high specificity of both modalities. All available pooled estimates are presented in Table 3.

Table 3. Pooled diagnostic performance of POCUS and supine CXR for traumatic pneumothorax

Diagnostic measure	Modality	Effect estimate	95% CI	I^2, %	Comparative p-value
Sensitivity	POCUS	87.3%	84.2%–90.0%	41.2	<0.001
Sensitivity	Supine CXR	48.2%	44.1%–52.3%	28.4	<0.001
Specificity	POCUS	98.2%	97.3%–98.9%	NR†	0.18
Specificity	Supine CXR	99.0%	98.3%–99.5%	NR†	0.18
Positive likelihood ratio	POCUS	48.5	32.1–73.2	NR†	NR†
Positive likelihood ratio	Supine CXR	48.2	28.4–81.8	NR†	NR†
Negative likelihood ratio	POCUS	0.13	0.10–0.17	NR†	NR†
Negative likelihood ratio	Supine CXR	0.52	0.48–0.57	NR†	NR†
Diagnostic odds ratio	POCUS	373.1	210–662	NR†	NR†
Diagnostic odds ratio	Supine CXR	92.7	52.1–164	NR†	NR†

CI, confidence interval; CXR, chest radiography; POCUS, point-of-care ultrasound; NR, not reported in the supplied meta-analysis output.
†These statistics require confirmation from the final diagnostic meta-analysis output before publication.

Study-level sensitivity estimates consistently favored POCUS over supine CXR. POCUS sensitivity ranged from 82.6% to 92.3%, whereas CXR sensitivity ranged from 41.3% to 53.8%. The corresponding 95% confidence intervals provided for each study are summarized in Table 4 and demonstrate that the direction of the comparative sensitivity difference was consistent throughout the supplied dataset.

Table 4. Study-level sensitivity estimates for POCUS and supine CXR

Study	POCUS sensitivity	95% CI	CXR sensitivity	95% CI
Ince et al. (2023)	0.89	0.80–0.95	0.49	0.37–0.61
Gibbons et al. (2023)	0.88	0.80–0.94	0.51	0.41–0.62
Kumar et al. (2023)	0.83	0.72–0.91	0.44	0.32–0.56
Bober et al. (2022)	0.85	0.78–0.91	0.47	0.38–0.56
Staub et al. (2022)	0.91	0.82–0.97	0.52	0.40–0.64
Alrajhi et al. (2021)	0.88	0.80–0.93	0.49	0.39–0.59
Tran et al. (2024)	0.87	0.78–0.93	0.44	0.34–0.55
Ranganath et al. (2026)	0.85	0.73–0.93	0.41	0.29–0.54
Zhao et al. (2021)	0.90	0.80–0.96	0.53	0.41–0.65
Patel et al. (2020)	0.86	0.78–0.92	0.47	0.37–0.56
Martinez et al. (2020)	0.92	0.81–0.98	0.54	0.40–0.68
Pooled estimate	0.87	0.84–0.90	0.48	0.44–0.52

Analysis according to operator experience suggested higher POCUS sensitivity when examinations were performed by experienced attending emergency physicians than when performed by resident trainees. The reported pooled sensitivities were 89.5% and 81.4%, respectively, with a between-group p-value of 0.018. Because operator experience was not randomized and may have been associated with differences in equipment, training, patient complexity, or scanning protocols, this result represents an exploratory source-of-heterogeneity analysis rather than evidence of an independent causal effect of operator seniority.

POCUS also identified a substantial proportion of pneumothoraces that were not apparent on initial supine radiography. Among CT-confirmed pneumothoraces classified as radiographically occult in the supplied synthesis, POCUS detected 79.4% (95% CI 72.8%–84.8%). The subgroup and occult-pneumothorax findings are summarized in Table 5.

Table 5. Subgroup and additional diagnostic synthesis findings

Analysis	Comparison/outcome	Effect estimate	95% CI	I^2, %	p-value
Operator experience	Attending physician POCUS sensitivity	89.5%	NR†	NR†	0.018‡
Operator experience	Resident-trainee POCUS sensitivity	81.4%	NR†	NR†	0.018‡
Radiographically occult pneumothorax	Proportion detected by POCUS	79.4%	72.8%–84.8%	NR†	NR†

†Not reported in the supplied analytic results.
‡Reported p-value for the attending-versus-resident subgroup comparison.

Overall, the quantitative synthesis consistently indicated substantially greater sensitivity for POCUS than for supine CXR, while both modalities retained very high specificity. The principal difference between the tests was therefore related to false-negative rather than false-positive classification: the pooled negative likelihood ratio was 0.13 for POCUS compared with 0.52 for CXR. The observed between-study variation in POCUS sensitivity was compatible with differences in operator expertise and diagnostic protocols, although these subgroup observations require cautious interpretation because the available data did not establish that operator experience was the sole source of heterogeneity.

DISCUSSION

This systematic review and diagnostic test accuracy meta-analysis found that bedside point-of-care ultrasound demonstrated substantially greater sensitivity than portable supine chest radiography for detecting traumatic pneumothorax in patients with blunt trauma, while both modalities maintained very high specificity. Pooled sensitivity was 87.3% for POCUS compared with 48.2% for supine CXR, corresponding to an absolute difference of 39.1 percentage points, whereas pooled specificity was 98.2% and 99.0%, respectively. The lower negative likelihood ratio observed with POCUS further indicates that a negative ultrasound examination was substantially more informative for reducing the probability of pneumothorax than a negative supine radiograph. In addition, POCUS identified 79.4% of CT-confirmed pneumothoraces that were not apparent on initial supine CXR. Collectively, these findings answer the primary review question by indicating that, within the synthesized evidence base, POCUS offers a clinically important sensitivity advantage over supine CXR without a meaningful loss of specificity.

The direction and magnitude of these findings are broadly consistent with previous diagnostic evidence showing that thoracic ultrasonography is more sensitive than supine radiography for pneumothorax detection (2,3,5). The principal explanation is anatomically and technically plausible. In a supine patient, intrapleural air tends to accumulate anteriorly and basally rather than at the lung apex, where it is more readily visualized on an upright radiograph. As a result, small or anterior pneumothoraces may remain occult on portable anteroposterior CXR despite being detectable with thoracic ultrasound. Earlier systematic evaluations similarly demonstrated high specificity for both tests but substantially reduced sensitivity for supine radiography (2,3,5). The present synthesis extends that evidence by concentrating specifically on non-upright blunt-trauma assessment and by evaluating the comparative performance of POCUS and portable CXR within the clinical circumstances in which conventional radiography is most vulnerable to false-negative findings.

The individual studies included in the synthesis also showed a consistent directional advantage for POCUS, with reported sensitivities ranging from 82.6% to 92.3%, compared with 41.3% to 53.8% for supine CXR. Contemporary comparative investigations have similarly reported greater pneumothorax detection with bedside ultrasound during acute trauma assessment (4,6–8). The consistency in direction is important because it suggests that the pooled sensitivity difference is not driven solely by one or two disproportionately favorable studies. However, the magnitude of POCUS performance varied across studies, indicating that its diagnostic accuracy should not be regarded as a fixed property of the technology independent of clinical context.

The moderate heterogeneity observed for POCUS sensitivity is clinically meaningful. Operator experience is one plausible contributor: the exploratory subgroup analysis showed sensitivity of 89.5% among attending emergency physicians compared with 81.4% among resident trainees. This difference supports the concept that image acquisition and interpretation remain operator dependent, but it should not be interpreted as proof that professional seniority itself causes better diagnostic performance. Training intensity, number of examinations previously performed, supervision, equipment quality, scanning-zone selection, patient complexity, and prevalence of technically difficult examinations may all differ between operator groups. Variation in transducer selection and thoracic scanning protocols may also influence detection, particularly for small anterior or apical pneumothoraces. Patient-related factors such as obesity, extensive subcutaneous emphysema, chest-wall injury, mechanical ventilation, or underlying pulmonary abnormalities may further impair visualization of pleural signs. Accordingly, implementation of POCUS in trauma systems should include standardized acquisition protocols, competency-based training, quality assurance, and recognition of circumstances in which ultrasound findings are indeterminate or technically limited rather than assuming uniform diagnostic performance across operators and settings.

Differences in reference-standard application provide another important source of heterogeneity and potential bias. Although thoracic CT represents the most sensitive reference standard for occult traumatic pneumothorax, CT may not be performed in every unstable trauma patient, particularly when immediate pleural decompression is clinically required. Selective verification can distort diagnostic accuracy estimates if patients with positive or highly suspicious index-test findings are more likely to undergo definitive confirmation than those with negative tests. The risk-of-bias assessment identified the reference-standard domain as the least consistently low-risk domain, with 72.7% of studies judged to be at low risk. Convenience or shift-dependent recruitment in some studies may also have altered the clinical spectrum of participants and consequently the observed sensitivity and specificity. These methodological differences should therefore be considered alongside the statistical heterogeneity rather than treating the I^2 value alone as a complete characterization of between-study variability.

From a clinical perspective, the most relevant finding is not simply that POCUS produced a higher pooled sensitivity, but that supine CXR failed to identify a substantial proportion of pneumothoraces subsequently detected by the reference standard. In severely injured patients who cannot be positioned upright, early bedside ultrasonography may therefore provide valuable diagnostic information during the primary or secondary trauma survey and may reduce reliance on a negative supine radiograph for excluding pneumothorax. Nevertheless, these diagnostic findings do not establish that POCUS should universally replace CXR or CT. Chest radiography provides information beyond pneumothorax detection, including assessment of fractures, tube positioning, mediastinal abnormalities, and other thoracic findings, while CT remains substantially more comprehensive for defining the extent of thoracic injury. POCUS is therefore most appropriately interpreted as a rapid bedside diagnostic component of an integrated trauma-imaging pathway rather than as a stand-alone substitute for all conventional thoracic imaging.

The findings also have implications for emergency-care policy and service organization. Trauma centers incorporating thoracic POCUS should prioritize structured education, supervised competency assessment, maintenance of operator proficiency, standardized reporting terminology, and mechanisms for correlation with subsequent radiographic or CT findings. Protocols should also specify when a negative or technically limited ultrasound examination is insufficient to exclude pneumothorax and when definitive cross-sectional imaging remains warranted. Such measures are particularly important because the diagnostic advantage observed in experienced operators may not be reproduced automatically in settings where training exposure, equipment availability, or quality-assurance systems are limited.

Several limitations of this review should be considered when interpreting the pooled estimates. First, the included studies differed in operator expertise, scanning protocols, transducer selection, diagnostic sonographic criteria, and reference-standard verification, all of which can influence measured test performance. Second, selective CT verification in some clinical pathways may have introduced partial-verification bias, particularly among low-risk patients or those requiring immediate intervention before CT. Third, restriction to English-language peer-reviewed reports may have excluded relevant evidence and introduced language or publication-selection bias. Fourth, subgroup findings according to operator experience were derived from study-level observational comparisons and are consequently susceptible to confounding and ecological interpretation. Fifth, variation in the unit of diagnostic analysis, pneumothorax prevalence, and extent of injury across trauma populations may limit direct transfer of pooled values to individual institutions. Finally, diagnostic accuracy alone does not demonstrate improvements in mortality, complication rates, time to definitive treatment, radiation exposure, emergency-department throughput, or cost-effectiveness.

Future research should therefore move beyond additional small single-center accuracy studies. Multicenter prospective studies should evaluate POCUS and supine CXR within the same patients using standardized thoracic scanning protocols, predefined diagnostic criteria, clearly documented operator training, and consistent CT-based reference verification whenever clinically appropriate. Investigators should report complete patient-level 2×2 diagnostic data, indeterminate examinations, technically limited scans, test timing, and operator characteristics to permit transparent comparative meta-analysis. Future studies should also evaluate clinically consequential outcomes, including time to pneumothorax recognition, time to intervention, unnecessary pleural procedures, missed clinically significant pneumothoraxes, CT utilization, radiation exposure, length of stay, and cost-effectiveness. Such evidence would determine whether the demonstrated diagnostic sensitivity advantage of POCUS translates into measurable improvements in trauma-care processes and patient outcomes.

CONCLUSION

In supine patients with blunt trauma, bedside point-of-care ultrasound demonstrated substantially greater pooled sensitivity than portable supine chest radiography for detecting traumatic pneumothorax while maintaining similarly high specificity. These findings support the use of thoracic POCUS as an important early bedside diagnostic modality, particularly when a negative supine radiograph may not reliably exclude pneumothorax;

however, the evidence does not justify universal replacement of chest radiography or computed tomography. Implementation should be accompanied by standardized scanning protocols, competency-based operator training, and appropriate confirmatory imaging when ultrasound findings are negative, indeterminate, or clinically discordant. Further multicenter comparative studies should determine whether the observed improvement in diagnostic sensitivity translates into faster treatment, fewer missed clinically important pneumothoraces, reduced imaging burden, and improved patient-centered outcomes.

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