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POINT-OF-CARE ULTRASOUND VERSUS CHEST RADIOGRAPHY FOR THE DETECTION OF PNEUMOTHORAX IN THE EMERGENCY DEPARTMENT: A REVIEW OF DIAGNOSTIC ACCURACY AND CLINICAL UTILITY

Yash Sanghvi *

A.T. Still University of Health Sciences, School of Osteopathic Medicine in Arizona.
* Corresponding Author

ORCID Details
Yash Sanghvi: https://orcid.org/0009-0006-5043-2268

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ABSTRACT

Pneumothorax is an important diagnosis in emergency medicine because delayed recognition can lead to respiratory compromise and, in severe cases, tension pneumothorax. Chest radiography has traditionally been one of the most commonly used initial imaging studies for suspected pneumothorax. However, point-of-care lung ultrasound has become increasingly incorporated into emergency and trauma evaluation because it can be performed rapidly at the bedside without radiation or patient transport. This review compares point-of-care ultrasound with chest radiography for detecting pneumothorax, focusing on sensitivity, specificity, speed, ultrasound findings, trauma applications, limitations, and practical emergency department use. Current evidence consistently demonstrates that lung ultrasound has greater sensitivity than portable supine chest radiography while maintaining similarly high specificity. A recent emergency department meta-analysis reported sensitivity of 79.4% for chest ultrasound compared with 48.1% for chest radiography, while specificity exceeded 99% for both methods. Although computed tomography remains the most sensitive imaging method for small or occult pneumothoraces, point-of-care ultrasound provides a rapid and effective bedside tool that can improve early recognition, particularly in trauma and critically ill patients. Ultrasound should complement rather than completely replace chest radiography because each modality provides different clinical information and ultrasound remains dependent on operator skill and patient factors.

Keywords: Point-Of-Care Ultrasound; Pneumothorax; Chest Radiography; Emergency Medicine; Lung Ultrasound; Trauma; eFAST

1 INTRODUCTION

Pneumothorax occurs when air enters the pleural space and separates the visceral and parietal pleura. The condition can develop spontaneously or as a result of trauma, invasive procedures, positive-pressure ventilation, or underlying

pulmonary disease. Although some pneumothoraces remain small and clinically stable, others can progress rapidly and lead to respiratory or hemodynamic compromise.

Rapid diagnosis is particularly important in emergency medicine. Trauma patients, critically ill patients, and those requiring mechanical ventilation may deteriorate quickly when a pneumothorax is missed. Traditionally, chest radiography has played a major role in the initial evaluation. However, portable chest radiographs are often obtained with the patient supine, particularly during trauma resuscitation. In this position, pleural air may collect anteriorly rather than at the lung apex, making a small or moderate pneumothorax more difficult to identify on radiography [1-3].

Point-of-care lung ultrasound has become an increasingly important part of emergency and critical care practice. Ultrasound can be performed immediately at the bedside, repeated as needed, and incorporated into the extended Focused Assessment with Sonography for Trauma examination. Several sonographic findings, including lung sliding, B-lines, lung pulse, and the lung point, can be used to assess for pneumothorax [4-6].

Multiple studies and meta-analyses have demonstrated that point-of-care ultrasound is more sensitive than supine chest radiography for detecting pneumothorax while maintaining high specificity [1-3,7].

This review compares point-of-care lung ultrasound with chest radiography for the diagnosis of pneumothorax in the emergency department, with emphasis on diagnostic accuracy, trauma applications, sonographic findings, limitations, and practical clinical use.

2 DIAGNOSTIC APPROACH TO PNEUMOTHORAX

The diagnosis of pneumothorax may involve clinical examination, point-of-care ultrasound, chest radiography, and computed tomography.

Physical findings may include decreased breath sounds, pleuritic chest pain, dyspnea, tachypnea, or hypoxia. However, physical examination alone may be unreliable, particularly when the pneumothorax is small or the patient has other injuries.

Computed tomography is generally considered the imaging reference standard because it can identify very small pneumothoraces that are missed on other imaging methods. However, computed tomography requires transportation away from the resuscitation area, takes additional time, exposes the patient to radiation, and may not be appropriate for unstable patients [3,6].

Chest radiography is widely available and provides information beyond pneumothorax alone, including rib fractures, pulmonary infiltrates, pleural effusions, mediastinal abnormalities, and placement of tubes and lines.

Point-of-care ultrasound provides a different advantage: rapid bedside assessment for the presence or absence of pneumothorax without radiation exposure.

3 ULTRASOUND TECHNIQUE AND FINDINGS

The pleural line is identified between two adjacent ribs. In a normal lung, the visceral and parietal pleura move against one another with respiration, producing lung sliding.

The presence of lung sliding strongly argues against pneumothorax at the location being examined because pleural air would separate the visceral and parietal surfaces.

B-lines are vertical artifacts that arise from the pleural line and extend toward the bottom of the ultrasound image. Because B-lines originate from the visceral pleural surface, their presence also argues against pneumothorax at that location [6,8].

A lung pulse refers to subtle movement of the pleural line caused by cardiac activity. When present, it also suggests that the visceral and parietal pleura remain opposed and therefore argues against pneumothorax [6].

When pneumothorax is present, lung sliding and B-lines are generally absent. M-mode ultrasound may demonstrate a stratosphere or barcode appearance rather than the normal seashore appearance.

The lung point represents the location where normal sliding lung intermittently meets an area without lung sliding. Lichtenstein and colleagues found the lung point to have 100% specificity for pneumothorax in their original study,

although its sensitivity was only 66% because the sign cannot always be identified, particularly with very large pneumothoraces [5].

Importantly, absent lung sliding alone does not confirm pneumothorax. Lung sliding may also be absent in conditions such as severe lung fibrosis, pleural adhesions, apnea, mainstem intubation, and other abnormalities. Multiple ultrasound findings should therefore be interpreted together with the clinical presentation [6,8].

4 DIAGNOSTIC SENSITIVITY

The largest advantage of point-of-care ultrasound compared with portable chest radiography appears to be sensitivity.

A 2025 systematic review and meta-analysis evaluated 15 studies involving 3,171 emergency department patients. Chest ultrasound demonstrated a pooled sensitivity of 79.4%, compared with only 48.1% for chest radiography [1].

A separate meta-analysis focusing specifically on trauma patients included 21 studies and 4,087 patients. Lung ultrasound demonstrated sensitivity of 83%, compared with 37% for chest radiography [2].

Earlier evidence demonstrated similar findings. A 2015 systematic review and meta-analysis reported pooled ultrasound sensitivity of 87%, compared with 46% for chest radiography [3].

These results have remained relatively consistent across several generations of research: lung ultrasound identifies a greater proportion of pneumothoraces than portable chest radiography, particularly when radiography is performed with the patient supine.

Table 1: Diagnostic performance reported in selected meta-analyses

Study	Population	Ultrasound sensitivity	Chest X-ray sensitivity	Ultrasound specificity	Chest X-ray specificity
2025 ED meta-analysis[1]	3,171 ED patients	79.4%	48.1%	99.5%	99.8%
2024 trauma meta-analysis[2]	4,087 trauma patients	83%	37%	99%	100%
Alrajab et al.[3]	Mixed suspected pneumothorax population	87%	46%	99%	100%

The exact sensitivity differs between studies because ultrasound performance depends on operator training, examination technique, patient population, pneumothorax size, and reference standard. Nevertheless, the overall direction of the evidence strongly favors ultrasound over supine radiography for sensitivity [1-3].

5 SPECIFICITY

Both point-of-care ultrasound and chest radiography demonstrate high specificity.

The 2025 emergency department meta-analysis reported specificity of 99.5% for ultrasound and 99.8% for chest radiography [1].

Similarly, the trauma meta-analysis found specificity of approximately 99% for ultrasound and 100% for chest radiography [2].

Therefore, the main difference between these imaging approaches does not appear to be specificity. Rather, ultrasound's major advantage is identifying pneumothoraces that would otherwise be missed by radiography.

The high specificity of certain sonographic findings is particularly helpful. For example, identification of a lung point is strongly supportive of pneumothorax [5].

6 EVIDENCE FROM PROSPECTIVE EMERGENCY DEPARTMENT STUDIES

Prospective studies provide additional support for bedside ultrasound.

Blaivas, Lyon, and Duggal prospectively evaluated 176 adult trauma patients undergoing computed tomography. Ultrasound demonstrated sensitivity of 98.1% and specificity of 99.2%, while supine chest radiography demonstrated sensitivity of 75.5% and specificity of 100% [9].

The study also found that ultrasound could provide information regarding the approximate size of the pneumothorax based on the location of ultrasound findings [9].

Kirkpatrick and colleagues evaluated extended FAST ultrasound for post-traumatic pneumothorax. Among the pneumothoraces identified in their trauma population, a substantial proportion were occult on chest radiography. Their findings helped support incorporation of thoracic ultrasound into trauma assessment [10].

These prospective studies contributed to the development of extended FAST examination protocols that now include assessment for pneumothorax in addition to abdominal free fluid, pericardial fluid, and hemothorax.

7 WHY CHEST RADIOGRAPHY MISSES PNEUMOTHORAX

Chest radiography performs differently depending on patient position.

In an upright patient, pleural air generally rises toward the apex, creating the classic appearance of a visible pleural line with absent lung markings beyond it.

However, critically ill and trauma patients frequently undergo portable anteroposterior radiography while lying supine. In the supine position, pleural air moves toward the anterior and medial portions of the thorax rather than collecting only at the apex [3,9].

This distribution can make pneumothorax much more difficult to recognize on chest radiography.

Ultrasound has an advantage because the clinician can intentionally examine the anterior chest, where pleural air commonly collects in a supine patient. The American College of Emergency Physicians recommends examining the anterior chest when evaluating a supine trauma patient for pneumothorax [6].

8 SPEED AND BEDSIDE AVAILABILITY

Another major advantage of point-of-care ultrasound is speed.

Ultrasound can be performed during the initial examination without moving the patient from the resuscitation area. This is particularly useful when evaluating unstable trauma patients.

A clinician performing the extended FAST examination can evaluate the pleural surfaces while simultaneously assessing for hemoperitoneum, pericardial effusion, and hemothorax.

Chest radiography requires positioning of the patient, availability of radiology equipment and personnel, image acquisition, and interpretation. Although portable radiography can generally be performed rapidly, ultrasound may provide information earlier when a trained clinician and ultrasound machine are immediately available.

This difference becomes most important when the patient is unstable and treatment decisions must be made quickly.

9 RADIATION EXPOSURE

Point-of-care ultrasound does not expose the patient to ionizing radiation.

For an individual emergency department visit, the radiation exposure associated with one chest radiograph is small. However, avoiding unnecessary radiation may be beneficial in children, pregnant patients, and patients who require repeated imaging.

Ultrasound can also be repeated frequently to monitor changes without additional radiation exposure.

Chest radiography nevertheless remains useful because it can evaluate conditions that point-of-care lung ultrasound cannot fully assess.

10 POINT-OF-CARE ULTRASOUND IN TRAUMA

Pneumothorax evaluation is now commonly incorporated into the extended FAST examination.

The examination is particularly useful during trauma resuscitation because pneumothorax may coexist with intra-abdominal bleeding, hemothorax, or pericardial effusion.

A systematic review examining extended FAST in trauma included 75 studies and more than 24,000 patients. For pneumothorax, pooled specificity was approximately 99%, although pooled sensitivity was lower at approximately 69% [7].

This finding highlights an important limitation: ultrasound is excellent when positive findings are identified, but a negative examination does not exclude every small pneumothorax.

For a stable patient with continuing clinical concern, additional imaging may therefore still be necessary.

10.1 Advantages of Point-of-Care Ultrasound

Point-of-care ultrasound offers several advantages in the emergency department. It can be performed immediately at the bedside, has greater sensitivity than portable supine chest radiography, does not expose patients to radiation, can be repeated as needed, and can be incorporated into the extended FAST examination [1-3,6].

It is particularly useful in unstable trauma patients who may not be suitable for immediate transport to computed tomography.

Modern evidence-based lung ultrasound recommendations continue to support point-of-care lung ultrasound as an important tool in emergency and critical care settings [11].

10.2 Advantages of Chest Radiography

Despite the advantages of ultrasound, chest radiography remains clinically important.

A chest radiograph evaluates more than the pleural interface. It can demonstrate pulmonary infiltrates, rib fractures, mediastinal abnormalities, pleural fluid, pulmonary edema, and the position of tubes and lines.

Chest radiography is also less dependent on the ultrasound skill of the treating clinician.

Radiographs can be permanently stored and interpreted by multiple physicians, including radiologists, whereas bedside ultrasound interpretation may be more operator dependent.

Therefore, the evidence supporting point-of-care ultrasound should not be interpreted to mean that chest radiography has no role in emergency evaluation.

10.3 Limitations of Point-of-Care Ultrasound

The most important limitation of point-of-care ultrasound is operator dependence.

Clinicians must correctly identify the pleural line and recognize findings such as lung sliding, B-lines, lung pulse, and lung point.

Patient-related factors can also reduce ultrasound quality. Obesity, subcutaneous emphysema, large dressings, chest-wall injuries, and limited patient positioning can make examination difficult [6].

Absent lung sliding is also not specific for pneumothorax. Pleural adhesions, pulmonary fibrosis, apnea, severe lung disease, and mainstem intubation may produce similar findings.

Furthermore, a small pneumothorax may be missed if the clinician does not scan the region where the pleural air is located. A limited examination of only one point on each side of the chest may therefore miss small pneumothoraces [6].

These limitations explain why computed tomography may still be required when clinical suspicion remains high despite a negative ultrasound examination.

10.4 Limitations of Chest Radiography

The primary limitation of chest radiography is reduced sensitivity, particularly with portable supine imaging.

Meta-analyses consistently report sensitivity below that of point-of-care ultrasound [1-3].

A negative supine chest radiograph therefore cannot reliably exclude a small or occult pneumothorax.

Chest radiography also involves radiation, requires imaging equipment and personnel, and may take longer than bedside ultrasound during active resuscitation.

However, its broader ability to evaluate thoracic structures remains an important advantage.

11 COMPUTED TOMOGRAPHY AS THE REFERENCE STANDARD

Neither ultrasound nor chest radiography detects every pneumothorax.

Computed tomography remains the most sensitive imaging method for small and occult pneumothoraces and serves as the reference standard in many diagnostic studies [1-3,9].

However, the purpose of point-of-care ultrasound is not necessarily to replace computed tomography. Rather, it provides rapid information that can guide immediate management before computed tomography is available or when transportation would be unsafe.

In an unstable patient with a clinical picture strongly concerning for tension pneumothorax, emergency treatment should not be delayed solely to obtain imaging.

12 DISCUSSION

The available evidence consistently demonstrates that point-of-care lung ultrasound is more sensitive than portable chest radiography for detecting pneumothorax while maintaining similarly high specificity.

The most recent emergency department meta-analysis found sensitivity of 79.4% for ultrasound compared with 48.1% for chest radiography [1]. Trauma-specific data demonstrate a similar difference, with sensitivity of 83% for ultrasound compared with 37% for radiography [2].

These findings are particularly relevant to emergency medicine because many critically ill and trauma patients undergo chest radiography while supine, the position in which radiographic detection of pneumothorax becomes more difficult.

The benefits of ultrasound extend beyond diagnostic accuracy. It can be performed during initial resuscitation, provides immediate information, does not require transportation, exposes the patient to no radiation, and can be repeated frequently.

However, point-of-care ultrasound should not be viewed as a complete replacement for chest radiography. Chest radiography provides information about a broader range of thoracic abnormalities and remains valuable in evaluating trauma, respiratory symptoms, and placement of medical devices.

A practical emergency department approach is therefore complementary rather than competitive. Point-of-care ultrasound may be the better initial bedside test when pneumothorax is the immediate clinical concern, particularly in an unstable or supine trauma patient. Chest radiography can then provide broader thoracic evaluation, while computed tomography remains appropriate when diagnostic uncertainty remains in a stable patient.

Training is also important. Ultrasound performs best when the clinician understands both the diagnostic signs and the conditions capable of producing false-positive or false-negative findings.

The 2026 focused update of international point-of-care lung ultrasound recommendations reflects the continued development of lung ultrasound as an established diagnostic tool in emergency and critical care medicine [11].

Limitations

This review has several limitations.

The studies included in the available literature vary substantially in patient population, operator training, ultrasound technique, patient positioning, prevalence of pneumothorax, and reference standard. This contributes to the wide range of reported sensitivity.

Many studies focus primarily on trauma patients. The findings may therefore not apply equally to spontaneous, iatrogenic, or mechanically ventilated pneumothorax.

Some of the most influential direct comparison studies were also performed many years ago. Ultrasound equipment, physician training, radiographic technology, and emergency department workflows have continued to improve.

Additionally, diagnostic accuracy alone does not demonstrate improved patient outcomes. Further research should evaluate whether routine early lung ultrasound reduces time to treatment, complications, computed tomography utilization, emergency department length of stay, or mortality.

13 CONCLUSION

Point-of-care lung ultrasound is a highly useful method for detecting pneumothorax in the emergency department. Current evidence demonstrates substantially greater sensitivity than portable supine chest radiography while maintaining similarly high specificity.

This advantage is particularly important in trauma and critically ill patients, where rapid recognition of pneumothorax can affect immediate management. Ultrasound also provides the benefits of bedside availability, repeatability, and absence of ionizing radiation.

Chest radiography nevertheless remains valuable because it provides a broader evaluation of the thorax and is less dependent on bedside ultrasound expertise. Computed tomography remains the most sensitive imaging method when the diagnosis remains uncertain.

Rather than viewing point-of-care ultrasound and chest radiography as competing tests, emergency physicians should use each according to its strengths. When pneumothorax is a primary concern, particularly in an unstable or supine trauma patient, point-of-care ultrasound provides a rapid and sensitive initial bedside assessment that can complement subsequent radiographic or computed tomographic imaging.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

Disclosure of conflict of interest

The author declares no conflicts of interest regarding this manuscript.

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