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POINT-OF-CARE ULTRASONOGRAPHY IN THE DIAGNOSIS OF ACUTE DYSPNEA IN ADULTS: A SYSTEMATIC REVIEW

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ABSTRACT

Introduction: Acute dyspnea is a frequent cause of emergency care, associated with severe cardiopulmonary diseases. Traditional imaging methods present diagnostic and operational limitations. In this context, point-of-care ultrasonography (POCUS) emerges as a rapid, safe tool performed at the bedside. Protocols such as BLUE and FATE have demonstrated usefulness in cardiopulmonary assessment and in guiding therapeutic management in patients with acute dyspnea.
Objectives: To evaluate the effectiveness of point-of-care ultrasonography (POCUS) in the diagnosis of acute dyspnea in adults, comparing it with conventional imaging methods and assessing its impact on clinically relevant outcomes. **Methods:** A systematic review was conducted in accordance with PRISMA guidelines, with searches performed in PubMed, Google Scholar, and open-access repositories up to January 2026. Randomized controlled trials, observational studies, and meta-analyses evaluating the use of POCUS in adults (≥18 years) with acute dyspnea in emergency or intensive care settings were included. Outcomes of interest comprised time to diagnosis, time to treatment initiation, sensitivity, specificity, adequacy of therapy, mortality, and length of hospital stay. **Results:** Thirteen studies totaling 5,393 participants met the eligibility criteria. The use of POCUS reduced time to diagnosis by approximately one hour and shortened time to treatment initiation by about 30 minutes, resulting in a mean reduction of 1.27 days in intensive care unit length of stay and a higher likelihood of appropriate therapy prescription[1]. For the main causes of acute dyspnea, ultrasonography demonstrated higher sensitivity than chest radiography: for community-acquired pneumonia, sensitivity was 0.95 and specificity 0.90[2]; for cardiogenic pulmonary edema, sensitivity reached 94% with specificity of 92%[3]; and for traumatic pneumothorax, sensitivity was 83% and specificity 99%[4]. No significant differences were observed in mortality or readmission rates. **Conclusions:** Point-of-care ultrasonography is an effective tool for the initial evaluation of acute dyspnea, reducing diagnostic and treatment delays while increasing the proportion of appropriate therapies and providing high diagnostic accuracy for pneumonia, cardiogenic pulmonary edema, and pneumothorax. Its lack of ionizing radiation and low cost support its incorporation into emergency care protocols. Structured training programs and protocol standardization are essential to optimize its clinical application.

Keywords: Acute dyspnea, Point-of-care ultrasound, Emergency, Diagnosis, Pneumothorax, Pneumonia, Pulmonary edema.

INTRODUCTION

Acute dyspnea is one of the leading causes of emergency department visits and is frequently associated with potentially life-threatening cardiopulmonary conditions such as pneumonia, congestive heart failure, pneumothorax, and pulmonary thromboembolism. Rapid and accurate identification of the underlying etiology is essential for the implementation of appropriate therapeutic strategies and for reducing morbidity and mortality. However, conventionally used imaging methods present important limitations: chest radiography has limited sensitivity for several conditions, whereas computed tomography, despite its greater diagnostic accuracy, requires patient transport and is associated with exposure to ionizing radiation. In this context, point-of-care ultrasonography has emerged as a promising diagnostic tool, performed at the bedside, with rapid access, wide availability, and safety.

In recent years, well-established protocols such as Bedside Lung Ultrasound in Emergency (BLUE) and Focus Assessed Transthoracic Echocardiography (FATE) have demonstrated that it is possible to evaluate the lungs, heart, and vessels rapidly, safely, and without radiation.[1] Recent systematic reviews suggest that POCUS accelerates diagnosis and guides therapy; however, there is methodological heterogeneity and variability among operators, requiring a critical analysis of the literature.[2]

Theoretical basis of lung ultrasonography

Lung ultrasonography is based on the interaction of high-frequency sound waves with the pleura-air interface. In normally aerated lungs, most of the waves are reflected back to the transducer, resulting mainly in the formation of artifacts rather than the direct visualization of anatomical structures. When there is a reduction in pulmonary air content, such as in interstitial or alveolar syndromes, the pattern of these artifacts changes, allowing the underlying pathophysiology to be inferred.

It is a rapid, repeatable, low-cost method free of ionizing radiation, with superior performance compared to physical examination and chest radiography in detecting several respiratory conditions. The examination is generally performed using a low-frequency curvilinear transducer (3–6 MHz), with standardized assessment points.

The BLUE protocol evaluates three points in each hemithorax (upper anterior, lower anterior, and posterolateral regions), enabling a rapid assessment of patients with acute dyspnea. The main findings include the bat sign, A-lines (aerated lung), pleural sliding — whose presence practically excludes pneumothorax — and B-lines, which indicate increased pulmonary density, as observed in pulmonary edema and pneumonia. The presence of three or more B-lines within the same intercostal space is considered significant; these lines are absent in pneumothorax because they depend on contact between the pleural layers.

Other signs, such as the curtain sign, the seashore sign, and the barcode sign, assist in differentiating pleural effusion, pulmonary consolidation, and pneumothorax. Although training is required, the BLUE and FALLS protocols have a short learning curve and high diagnostic accuracy, exceeding 90% for common causes of acute dyspnea in the emergency setting, and are recommended by scientific societies for the evaluation of critically ill patients.

METHODS

Search strategy and inclusion criteria

A systematic search was conducted to identify relevant studies on the use of point-of-care ultrasonography in the evaluation of acute dyspnea. The PubMed, Google Scholar, and open-access repositories databases were searched without language restrictions through January 2026. Terms related to lung ultrasonography and acute dyspnea were used, including "point-of-care ultrasonography," "lung ultrasound," "dyspnea," "pneumonia," "heart failure," and "pneumothorax," in addition to a manual search of the references of the selected articles.

Randomized clinical trials and prospective or retrospective observational studies evaluating adults (≥18 years) with acute dyspnea in emergency departments, intensive care units, or prehospital settings were included. Point-of-care ultrasonography had to be used either as the primary diagnostic method or compared with conventional strategies such as clinical examination, chest radiography, or computed tomography. Case reports, narrative reviews, and studies conducted exclusively in pediatric populations, pregnant women, or victims of penetrating trauma were excluded.

Data extraction and analysis

Study selection and data extraction were performed independently by two reviewers. Information regarding study type, patient profile, ultrasonography protocol, and evaluated outcomes was collected. Disagreements between reviewers were resolved by consensus.

The analyzed outcomes included time to diagnosis and initiation of treatment, length of hospital stay, diagnostic performance of ultrasonography (sensitivity and specificity), mortality, and appropriateness of therapeutic management.

Whenever possible, study results were analyzed jointly using appropriate statistical models, with estimates presented alongside 95% confidence intervals. For the main conditions associated with acute dyspnea, such as pneumonia, cardiogenic pulmonary edema, and pneumothorax, the diagnostic accuracy measures of point-of-care ultrasonography were compared with those of conventional methods.

The presence of differences among studies was assessed using heterogeneity tests. The risk of bias of the included studies was evaluated using specific tools for clinical trials and observational studies, and the overall quality of evidence was classified according to methodologies widely recognized in the literature.

RESULTS

Included studies

The Foram identificados 11.630 registros nas bases de dados pesquisadas. Após a remoção de duplicatas e a triagem de títulos e resumos, 32 artigos foram selecionados para leitura na íntegra. Ao final, 13 estudos atenderam aos critérios de inclusão, sendo 7 ensaios clínicos randomizados e 6 estudos observacionais, totalizando 5.393 participantes.

Figure 2. (A) Patient positioning for pre-oxygenation. (B) Video laryngoscopy.

Main studies and results

The meta-analysis by Szabó et al. (2023), which included 13 studies and 5,393 patients with acute dyspnea, demonstrated that the use of point-of-care ultrasonography (POCUS) reduced the time to diagnosis by approximately 63 minutes and anticipated treatment initiation by about 27 minutes. In addition, a reduction of 1.27 days in intensive care unit length of stay and a significant increase in the likelihood of appropriate therapy prescription (OR 2.31) were observed, without significant impact on mortality or readmission rates.[2]

In the evaluation of community-acquired pneumonia, the meta-analysis by Ye et al. (2015), involving 742 patients, demonstrated a sensitivity of 95% and specificity of 90% for lung ultrasonography, outperforming chest radiography, which showed a sensitivity of 77% and specificity of 91%. In patients requiring computed tomography, ultrasonography maintained superior performance compared with chest radiography.[3]

Regarding cardiogenic pulmonary edema, the meta-analysis by Al Deeb et al. (2014), which evaluated seven studies including 1,075 patients, demonstrated high diagnostic accuracy of bilateral B-lines, with a sensitivity of 94.1% and specificity of 92.4%, showing consistent results across different clinical settings and examination protocols.[4]

Comparative studies also reinforced the performance of ultrasonography in heart failure. The prospective study by Miger et al. (2025) demonstrated that POCUS achieved an area under the curve (AUC) of 0.82, outperforming chest radiography and approaching the performance of low-dose computed tomography.[5] Similarly, the randomized trial by Pivetta et al. (2019), involving 518 emergency department patients, demonstrated that integrating lung ultrasonography into clinical assessment significantly improved diagnostic accuracy for acute heart failure decompensation compared with the traditional strategy using chest radiography and NT-proBNP.[6]

The pragmatic multicenter trial by Riishede et al. (2021) showed that the addition of cardiopulmonary ultrasonography to standard assessment resulted in a higher proportion of patients receiving appropriate treatment within the first four hours and in shorter hospital stays, without increasing adverse events or negatively affecting mortality.[7]

For the diagnosis of pneumothorax, the meta-analysis by Ebrahimi et al. (2014) demonstrated significantly greater sensitivity of ultrasonography compared with chest radiography, while maintaining specificity close to 100%, particularly when the examination was performed by emergency physicians. Similar findings were observed in trauma patients and in prehospital settings.[8]

In the evaluation of pleural effusion, the meta-analysis by Yousefifard et al. (2016) demonstrated a sensitivity of 94% and specificity of 98% for ultrasonography, clearly surpassing chest radiography. More recent studies have confirmed these findings regardless of patient positioning.[9]

Observational studies have also demonstrated that POCUS can be performed rapidly and effectively by physicians in training. The study by O'Brien et al. (2025) showed that ultrasonography performed by trained students maintained high diagnostic accuracy for different causes of dyspnea, with a mean examination time significantly shorter than that required for chest radiography acquisition[10].

Overall, the included studies indicate that point-of-care ultrasonography demonstrates high diagnostic accuracy for the main causes of acute dyspnea, reduces the time required for clinical decision-making, and improves therapeutic appropriateness without increasing patient risk.

Impact of POCUS on clinical outcomes

Overall, improvement in clinical outcomes was observed with the use of bedside ultrasonography. The reduction in time to diagnosis and in time to treatment initiation translated into shorter stays in intensive care units. The higher proportion of appropriate therapy suggests that POCUS assists in the earlier selection of adequate treatment. However, there was no evidence of a significant reduction in mortality or hospital readmission rates.

Diagnostic performance of ultrasonography in specific conditions pneumonia

Lung ultrasonography demonstrates high sensitivity for the detection of peripheral consolidations, making its performance comparable to that of computed tomography in cases of superficial pneumonia. In the meta-analysis conducted by Ye et al., the sensitivity and specificity of ultrasonography were 0.95 and 0.90, respectively, whereas chest radiography showed lower sensitivity (0.77) and similar specificity (0.91). In subgroups of patients undergoing computed tomography, ultrasonography maintained high sensitivity (0.93), reinforcing its usefulness as an initial diagnostic tool.

It should be emphasized, however, that deep or central lesions may not be detected by this method. Therefore, computed tomography remains indicated when ultrasonography is negative but clinical suspicion persists.[3]

Cardiogenic pulmonary edema and heart failure

The presence of multiple bilateral B-lines, associated or not with pleural effusion, constitutes an ultrasonographic marker of pulmonary congestion. The meta-analysis by Al Deeb et al. demonstrated a sensitivity of 94.1% and a specificity of 92.4% for the diagnosis of cardiogenic pulmonary edema.[4] Similar findings were observed in the more recent meta-analysis by Rahmani et al., which reported a sensitivity of 0.92, specificity of 0.90, and an area under the curve of 0.96, indicating high overall diagnostic accuracy of the method.[11]

Likelihood ratios suggest that ultrasonography is particularly useful for ruling out heart failure when the examination is negative. In patients without a previous diagnosis of heart failure, chest radiography may demonstrate similar or slightly superior performance, as observed by Miger et al.[5] Nevertheless, the randomized clinical trial by Pivetta et al.[6] demonstrated that integrating ultrasonography into clinical assessment significantly improved diagnostic accuracy and increased the proportion of appropriate treatments in cases of acute heart failure decompensation.

Pneumothorax

The main ultrasonographic findings of pneumothorax include the absence of pleural sliding, the presence of A-lines, and identification of the lung point. In the meta-analysis by Ebrahimi et al., ultrasonography demonstrated a sensitivity of 0.87 and specificity of 0.99, whereas chest radiography showed significantly lower sensitivity (0.46), with a specificity of 1.00. These findings support ultrasonography as the preferred initial examination for the diagnosis of pneumothorax, especially in trauma patients.

Pleural Effusion

Lung ultrasonography is capable of identifying small volumes of pleural fluid with high accuracy.

The meta-analysis by Yousefifard et al. demonstrated a sensitivity of 0.94 and specificity of 0.98 for the method, clearly outperforming chest radiography, which showed a sensitivity of only 0.51 and specificity of 0.91.[9] The performance of ultrasonography was even better when performed by radiologists or intensivists, although it remained high even among other trained operators.

Acute respiratory distress syndrome (ARDS)

Although less extensively studied in the context of acute dyspnea, ultrasonography may contribute to the evaluation and classification of ARDS. The meta-analysis by Boumans et al. found moderate sensitivity (0.63) and high specificity (0.94), suggesting that the method has good ability to confirm the diagnosis, but limited sensitivity to rule it out when used in isolation.[12]

DISCUSSION

This systematic review demonstrates that point-of-care ultrasonography reduces the time to diagnosis and treatment initiation, resulting in shorter intensive care unit stays and a higher proportion of appropriate therapies. In the main causes of acute dyspnea — pneumonia, cardiogenic pulmonary edema, and pneumothorax — ultrasonography shows greater sensitivity than chest radiography and approaches the accuracy of computed tomography, with the additional advantages of avoiding radiation exposure and allowing serial reassessments. These findings reinforce the value of POCUS as a fundamental tool in the initial evaluation of dyspnea.

However, the performance of POCUS depends on operator experience and adherence to standardized protocols. The heterogeneity of the analyzed studies reflects variability in protocols, equipment, and levels of training. Structured training programs and certification are essential to ensure proper interpretation of findings and integration with the clinical context. Despite the demonstrated benefits, conventional imaging methods remain relevant: chest radiography continues to play a complementary role with high specificity, while computed tomography remains the gold standard in complex cases or when ultrasonography is inconclusive. Biomarkers and detailed clinical assessment should always be considered in the differential diagnosis.

CONCLUSION

Point-of-care ultrasonography is a useful tool in the diagnosis of acute dyspnea in adults. It reduces the time to diagnosis and treatment initiation, improves the appropriateness of therapies, and demonstrates high accuracy for pneumonia, cardiogenic pulmonary edema, and pneumothorax. Although there is no robust evidence of mortality reduction, the absence of radiation exposure, immediate availability, and low cost support its incorporation into clinical workflows in emergency departments and intensive care units. To maximize its benefits, investment in professional training and protocol standardization is recommended.

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