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Use of bedside ultrasound in the evaluation of acute dyspnea: a comprehensive review of evidence on diagnostic usefulness

Iván David Lozada Martínez[1], Isabela Zenilma Daza Patiño[2], Gerardo Jesús Farley Reina González[3], Sebastián Rojas Pava[4], Ailyn Zenith Angulo Lara[2], María Paola Carmona Rodiño[5], Olga Gissela Sarmiento Najar[6], Jhon Mike Romero Madera[7], Yesid Alonso Ángel Hernández[8]

Abstract

Introduction: Acute dyspnea is one of the most frequently observed symptoms in emergency departments, which can be caused mainly by pulmonary or cardiac system involvement. Bedside ultrasound is postulated as an innovative tool for basic use by the physician, which can complement the physical examination and quickly explore the integrity of thoracic structures. **Objectives**: To synthesize recent evidence on the use of bedside ultrasound in the evaluation of acute dyspnea. **Materials and methods**: A bibliographic search was carried out using search terms such as "Bedside Ultrasound" and "Acute Dyspnea," as well as synonyms, which were combined with Boolean operators, in the databases PubMed, ScienceDirect, Embase, EBSCO, and MEDLINE. **Results**: During the literature review, 10 observational studies, 2 clinical trials and 2 systematic reviews met the inclusion criteria and were analyzed. The use of bedside ultrasound changes the main diagnosis associated with acute dyspnea in more than 60% of cases, the most frequent being acute decompensated heart failure and pneumonia. Protocols such as SEARCH 8Es for the evaluation of dyspnea in the emergency department, has a performance with sensitivity, specificity, positive and negative predictive value parameters above 95%. **Conclusions**: The current evidence on the use of bedside ultrasound in the management of patients with acute dyspnea in the emergency department is limited, Although the level of evidence is not the best, it suggests that this tool may promote the diagnostic perfomance of acute dyspnea of pulmonary or cardiac causes, improve the time to diagnosis, and enhance physician diagnostic confidence. **Keywords:** ultrasonography; point-of-care systems; dyspnea; evidence-based medicine; review literature as topic.

[1] Grupo Prometheus y Biomedicina Aplicada a las Ciencias Clínica, School of Medicine, Universidad de Cartagena, Cartagena – Colombia. International Coalition on Surgical Research, Universidad Nacional Autónoma de Nicaragua, Managua – Nicaragua. [2]School of Medicine, Universidad Libre, Barranquilla – Colombia. [3] School of Medicine, Universidad del Tolima, Ibagué – Colombia. [4] School of Medicine, Universidad del Rosario, Bogotá – Colombia. [5] School of Medicine, Universidad Metropolitana, Barranquilla – Colombia. [6] School of Medicine, Universidad de Ciencias Aplicadas y Ambientales, Bogotá – Colombia. [7] School of Medicine, Universidad del Sinú, Montería – Colombia. [8] School of Medicine, Fundación Universitaria Juan N Corpas, Bogotá – Colombia.

Corresponding author: Iván David Lozada Martínez. E-mail: ilozadam@unicartagena.edu.co

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Uso de ecografía a pie de cama en la evaluación de la disnea aguda: una revisión exhaustiva de la evidencia sobre su utilidad diagnóstica

Resumen

Introducción: La disnea aguda es uno de los síntomas más observados en los servicios de urgencias, que puede estar causada por la afectación del sistema pulmonar o cardiaco. La ecografía a pie de cama se postula como una herramienta innovadora, al complementar la exploración física con la evaluación rápida de las estructuras intratorácicas.

Objetivo: Sintetizar la evidencia reciente sobre el uso de la ecografía a pie de cama en la evaluación de la disnea aguda.

Materiales y métodos: Búsqueda bibliográfica utilizando términos de búsqueda como *Bedside Ultrasound* y *Acute Dyspnea*, así como sinónimos, que se combinaron con operadores booleanos, en cinco bases de datos.

Resultados: Se evidenció que el uso de la ecografía a pie de cama cambia el diagnóstico principal asociado con la disnea aguda en más del 60 % de los casos, entre los cuales los más frecuentes fueron la insuficiencia cardiaca aguda descompensada y la neumonía. Protocolos como el SEARCH 8Es para la evaluación de la disnea en el servicio de urgencias tiene un rendimiento con parámetros de sensibilidad, especificidad, valor predictivo positivo y negativo superiores al 95 %.

Conclusión: La evidencia actual sobre el uso de la ecografía a pie de cama en el tratamiento de los pacientes con disnea aguda en el servicio de urgencias es limitada. No obstante, sugiere que esta herramienta puede favorecer el rendimiento diagnóstico de la disnea aguda de causa pulmonar o cardiaca, mejorar el tiempo de diagnóstico y aumentar la confianza del médico en el diagnóstico.

Palabras clave: ultrasonografía; sistemas de punto de atención; disnea; medicina basada en la evidencia; revisión de la literatura como tema.

Uso de ultrassom à beira do leito na avaliação da dispneia aguda: uma revisão abrangente das evidencias sobre sua utilidade diagnostica

RESUMO

Introdução: A dispneia aguda é um dos sintomas mais observados no departamento de emergência, que pode ser causado pela afetação do sistema pulmonar o cardíaco. O ultrassom à beira do leito é proposto como uma ferramenta inovadora, complementando o exame físico com uma rápida avaliação das estruturas intratorácicas.

Objetivo: sintetizar evidências recentes sobre o uso do ultrassom à beira do leito na avaliação da dispneia aguda.

Materiais e métodos: Pesquisa de literatura usando termos de busca tais como *Bedside Ultrasound* e *Acute Dyspnea*, bem como sinônimos, que foram combinados com operadores booleanos, em cinco bancos de dados.

Resultados: O uso do ultrassom á beira do leito mostrou a mudança do principal diagnóstico associado com a dispneia aguda em mais de 60% dos casos, sendo o mais frequente a insuficiência cardíaca descompensada aguda e a pneumonia. Protocolos como o SEARCH 8Es para a avaliação da dispneia no serviço de emergência tem um desempenho com parâmetros de sensibilidade, especificidade, valor preditivo positivo e negativo superiores ao 95%.

Conclusão: As evidencias atuais sobre o uso do ultrassom á beira do leito no gerenciamento de pacientes com dispneia aguda no serviço de emergências são limitadas. No entanto, sugere que esta ferramenta pode favorecer o rendimento diagnóstico da dispneia aguda de causa pulmonar ou cardíaca, melhorar o tempo de diagnóstico e aumentar a confiança do médico no diagnóstico.

Palavras-chave: ultrassom; sistemas de ponto de tratamento; dispneia; medicina baseada em evidências; revisão de literatura como tópico.

INTRODUCTION

Acute dyspnea is one of the most common symptoms in the emergency department (1). The approach to this symptom depends on a number of factors, which may represent primary or secondary organ involvement, the most frequently involved being the lungs and heart (2,3). Adequate and timely management is a challenge because it depends on the patient's pathological history, the treating physician and the availability of tools for the evaluation of the acute condition (2). Traditionally, the physical examination has been used as the tool to guide the physician to a presumptive diagnosis. However, with the rise of academic and precision medicine in recent years, it has been observed the development of diagnostic tools that have made it possible to accelerate health care without reducing the quality of care (4,5). The use of bedside ultrasound (or also known as Point-of-Care Ultrasound: PoCUS) has been proposed several years ago, but has not yet been widely replicated in low- and middle-income countries (6-8). This tool allows rapid assessment of the integrity of intrathoracic structures, in order to identify the cause or severity of a condition that generates respiratory or cardiac symptomatology (6). Studies consistent with the highest level of evidence have found that the performance of this instrument is adequate in the diagnosis of cardiogenic pulmonary edema (one of the most frequently reported conditions associated with dyspnea), with sensitivity and specificity values above 90% (7,8); this performance is maintained when attempting to differentiate dyspnea of cardiogenic vs. pulmonary origin (9).

Despite the above, the existing guidelines that focus on recommending the use and reproducibility of bedside ultrasound come from high-income countries, which generates a gap in the evidence on the external validity of the results and recommendations applicable in third world countries (10). This question makes it difficult to train medical students and physician in the management of dyspnea with recent technological tools, causing a gap between traditional practice and recent evidence-based practice (9-11). Probably the lack of knowledge of the global performance of bedside ultrasound does not facilitate the design of studies in third world countries and the evaluation of the performance of this portable, cost-useful and cost-effective tool. In this vein, the aim of this review is to synthesize recent evidence that has evaluated the usefulness of bedside ultrasound in the evaluation of acute dyspnea in the emergency department.

METHODS

A bibliographic search was carried out using search terms such as *Bedside Ultrasound* and *Acute Dyspnea*, as well as synonyms, which were combined with the Boolean operators AND and

OR, in the databases PubMed, ScienceDirect, Embase, EBSCO, and MEDLINE. As inclusion criteria, any article related to the evaluation of bedside ultrasound performance in patients with dyspnea who have attended the emergency department would be included, giving priority to original studies and systematic reviews and meta-analyses. In addition, they had to be available in full text. As non-inclusion criteria, it was established that articles published in a language other than Spanish and English would not be included. Taking into account the breadth of the topic and the wide variety of publications, articles published between 2000 and 2022 were included. A total of 127 potentially relevant articles were identified, with a review of the title and abstract of all of them, of which 33 articles were finally included, after discrimination according to the inclusion and non-inclusion criteria. The estimates and calculations found were expressed in their original measures, whether frequencies, percentages, confidence intervals (CI), mean difference (MD), relative risk (RR), odds ratio (OR) or hazard ratio (HR).

Relevance and usefulness of a bedside diagnostic tool in the approach to acute dyspnea in the emergency department

The accuracy of dyspnea assessment in the emergency department or intensive care unit can be biased by both organic conditions and situations in the clinical environment (7,8). Auscultation in obese patients, elderly, with chronic obstructive pulmonary disease (COPD), or in an environment where noise predominates or where there are no good quality instruments, does not really allow us to determine the origin and severity of dyspnea, and whether or not there is the presence of another active pathophysiological process (7,8). Bedside ultrasound, on the other hand, allows rapid visualization of intrathoracic structures and facilitates the execution of a decision-making algorithm that helps control of organic decompensation, reducing the frequency of complications, morbidity and mortality (10). Therefore, a global knowledge of the recent evidence will allow us to verify in which cases it is more appropriate to use this tool, and to promote the practice of care. The following will discuss the evidence from the lowest to the highest level (from observational studies to systematic reviews and meta-analyses) on the usefulness of bedside ultrasound in the evaluation of acute dyspnea:

Observational studies

During the literature review, 7 cross-sectional (12-18) and 3 cohort (19-21) studies were found (Table 1). All of the studies reviewed were in favor of the use of bedside ultrasound in the evaluation of the patient with dyspnea in the emergency department.

Table 1. Summary of the characteristics of the included observational studies on use of bedside ultrasound in the evaluation of acute dyspnea (12-21)

Authors	Objective	Methods	Results	Conclusions
Cibinel et al. (12)	To evaluate the diagnostic accuracy and reproducibility of pleural and lung ultrasound, performed by emergency physicians, in identifying cardiac causes of acute dyspnea.	Prospective cross-sectional study involving 56 patients with acute dyspnea to the emergency department.	The presence of diffuse alveolar-interstitial syndrome was highly predictive for cardiogenic dyspnea (sensitivity 93.6%, specificity 84%, positive predictive value 87.9%, negative predictive value 91.3%). On the contrary, US detection of pleural effusion was not helpful in the differential diagnosis (sensitivity 83.9%, specificity 52%, positive predictive value 68.4%, negative predictive value 72.2%).	In early evaluation of patients presenting to the emergency department with dyspnea, PoCUS, performed with the purpose of identifying diffuse alveolar-interstitial syndrome, may represent an accurate and reproducible bedside tool in discriminating between cardiogenic and non-cardiogenic dyspnea.
Zanobetti et al. (13)	to evaluate the feasibility and diagnostic accuracy of PoCUS for the management of patients with acute dyspnea in the emergency department.	Prospective cross-sectional study involving 2683 patients with acute dyspnea to the emergency department.	The average time needed to formulate the ultrasound diagnosis was significantly lower than that required for emergency department diagnosis (24 ± 10 min vs. 186 ± 72 min; p = 0.025). The ultrasound and the emergency department diagnoses showed good overall concordance. PoCUS was significantly more sensitive for the diagnosis of heart failure.	PoCUS represents a feasible and reliable diagnostic approach to the patient with dyspnea, allowing a reduction in time to diagnosis.
Buhumaid et al. (14)	To determine how use of PoCUS impacted emergency physicians' differential diagnosis, and evaluate the accuracy of PoCUS when compared to chest radiograph and composite final diagnosis.	Prospective cross-sectional study involving 128 patients with acute dyspnea to the emergency department.	PoCUS had equal or higher specificity to chest x-ray for all indications for which it was used, except for pneumonia. PoCUS correctly identified all patients with pneumothorax, pleural effusion and pericardial effusion. In patients with a normal thoracic ultrasound, chest x-ray never provided any actionable clinical information.	In evaluation of patients with shortness of breath, PoCUS is a highly feasible diagnostic test which can assist in narrowing down the differential diagnoses. In patients with a normal thoracic ultrasound, the added value of a chest radiograph may be minimal.

Papanagnou et al. (15)	To examine the impact of a bedside, clinician-performed cardiopulmonary US protocol on the clinical impression of emergency physicians evaluating dyspneic patients.	Prospective cross-sectional study involving 115 patients with acute dyspnea to the emergency department.	The most common diagnosis before ultrasound was congestive heart failure (41%; 95% CI: 32-50%), followed by chronic obstructive pulmonary disease and asthma. Congestive heart failure remained the most common diagnosis after ultrasound (46%; 95% CI: 38-55); chronic obstructive pulmonary disease became less common (pre-US: 22%; 95% CI: 15-30%; post-US: 17%, 95% CI: 11-24%). Post-US clinical diagnosis matched the final diagnosis 63% of the time (95% CI: 53-70%), compared to 69% pre-US (95% CI: 60-76%).	Bedside ultrasound did not improve the diagnostic accuracy in physicians treating patients presenting with acute undifferentiated dyspnea. Ultrasound, however, did improve providers' confidence with their leading diagnosis.
Umuhire et al. (16)	To determine the proportion of cases presenting with acute dyspnea in which ultrasound changes the clinician's diagnosis for the patient.	Prospective cross-sectional study involving 100 patients with acute dyspnea to the emergency department.	The most frequent discharge diagnoses were acute decompensated heart failure (26.3%) and pneumonia (21.2%). Ultrasound changed the leading diagnosis in 66% of cases. The diagnostic accuracy for acute decompensated heart failure increased from 53.8 to 100% ($p = 0.0004$), from 38 to 85.7% for pneumonia ($p = 0.0015$), from 14.2 to 85.7% for extrapulmonary tuberculosis ($p = 0.0075$), respectively, pre and post-ultrasound.	In dyspneic patients, ultrasound frequently changed the leading diagnosis, significantly increased clinicians' confidence in the leading diagnoses, and improved diagnostic accuracy.
Perrone et al. (17)	To define the role of bedside US in the differential diagnosis of dyspnea in patients admitted to the internal medicine department.	Prospective cross-sectional study involving 130 patients with acute dyspnea to the internal medicine ward.	The presence of a generalized interstitial syndrom at the initial ultrasound evaluation allowed to discriminate cardiac from pulmonary dyspnea with high sensitivity (93.75%; 95% CI: 86.01%-97.94%) and specificity (86.11%; 95% CI: 70.50%-95.33%). Positive and negative predictive values were 93.76% (95% CI: 86.03%-97.94%) and 86.09% (95% CI: 70.47%-95.32%).	Bedside ultrasound evaluation contributes with high sensitivity and specificity to the differential diagnosis of dyspnea. This holds true not only in the emergency setting, but also in the sub-acute internal medicine arena.

Ahn et al. (18)	To evaluate a problem-oriented focused torso bedside ultrasound protocol termed "Sonographic Evaluation of Aetiology for Respiratory difficulty, Chest pain, and/or Hypotension" (SEARCH 8Es).	Single-center, prospective, observational study involving 308 patients with acute dyspnea, chest pain, and/or hypotension to the emergency department.	SEARCH 8Es narrows the number of differential diagnoses (2.5 ± 1.5 vs. 1.4 ± 0.7; $p < 0.001$) and improves physicians' diagnostic confidence (2.8 ± 0.8 vs. 4.3 ± 0.9; $p < 0.001$) significantly. The overall kappa coefficient value was 0.870 ($p < 0.001$).	The SEARCH 8Es protocol helps emergency physicians to narrow the differential diagnoses, increase diagnostic confidence and provide accurate assessment of patients with dyspnea.
Gallard et al. (19)	To evaluate the performance of cardiopulmonary ultrasound compared with usual care for the etiologic diagnosis of acute dyspnea in the emergency department.	Prospective cohort study involving 130 patients with acute dyspnea to the emergency department.	For the diagnosis of acute left-sided heart failure, cardiopulmonary ultrasound had an accuracy of 90% (95% CI: 84-95) vs. 67% (95% CI: 57-75), $p = 0.0001$, for clinical examination, and 81% (95% CI: 72-88), $p = 0.04$, for the combination clinical examination / NT-proBNP / x-ray. Cardiopulmonary ultrasound led to the diagnosis of pneumonia or pleural effusion with an accuracy of 86% (95% CI: 80-92).	Cardiopulmonary ultrasounds performed in the emergency department setting allow one to rapidly establish the etiology of acute dyspnea with an accuracy of 90%.
Beyer et al. (20)	To evaluate the effectiveness of PoCUS in narrowing diagnostic uncertainty in dyspneic patients when performed by treating emergency physicians vs. separate US teams.	Multicenter, prospective noninferiority cohort study, involving 156 patients with acute dyspnea to the emergency department.	In the primary team group, most likely diagnosis changed in 40% (95% CI: 28-52%) of encounters vs. 32% (95% CI: 22-41%) in the ultrasound team group. This was noninferior using an a priori specified margin of 20% ($p < 0.0001$).	PoCUS performed by primary teams was noninferior to PoCUS performed by ultrasound teams for changing the most likely diagnosis, and equivalent when considering mean reduction in number of diagnoses. PoCUS performed by treating emergency physicians reduces cognitive burden in dyspneic patients.
Nakao et al. (21)	To determine the classification performance of lung PoCUS compared with chest x-ray study to identify acute heart failure in an older population.	Prospective cohort study involving 81 patients with acute dyspnea to the emergency department.	Emergency physicians identified acute heart failure by lung PoCUS with sensitivity of 92.5% (95% CI: 83.4-97.5%) and specificity of 85.7% (95% CI: 57.2-98.2%). The radiology reading of chest x-ray study had sensitivity of 63.6% (95% CI: 50.9-75.1%) and specificity of 92.9% (95% CI: 66.1-99.8%).	Lung PoCUS in a real clinical setting was highly sensitive and specific in identifying acute heart failure, and performed better than chest x-ray in an older population.

Cibinel et al. (12) conducted a study including 56 patients with acute dyspnea, with the aim of evaluating the accuracy and reproducibility of pulmonary and pleural ultrasound, to distinguish whether the cause was cardiac or non-cardiac. For this, they took as a parameter of comparison the presence of pleural effusion and diffuse interstitial-alveolar syndrome (AIS). The authors showed that the presence of AIS was highly predictive for dyspnea of cardiogenic origin (with predictive parameter values above 80% - 90%), while the finding of pleural effusion or the coexistence of these two patterns did not help to differentiate the origin of dyspnea. An interesting fact to note is that no significant difference was found between the operator's experience and the diagnostic success rate (92.2% for experienced operators vs. 95% for non-experienced operators; $p < 0.01$) (12).

Zanobetti et al. (13) studied 2683 patients with acute dyspnea prospectively with bedside ultrasound compared to traditional clinical diagnostic performance, observing that the time needed to the definitive diagnosis is substantially reduced with the use of bedside ultrasound (approximately 90%). However, it was found that this tool was more sensitive for the diagnosis of dyspnea secondary to heart failure, while the traditional assessment was more sensitive for pulmonary embolism and asthma or COPD (13). However, compared to chest radiography, bedside ultrasound has a higher specificity for diagnosis associated with dyspnea in the emergency department, with the exception of pneumonia (14). Pneumothorax, pulmonary and pericardial effusion are the entities most accurately diagnosed with ultrasound (14).

On the differences in diagnostic accuracy before and after the use of bedside ultrasound in the patient with acute dyspnea, Papanagnou et al. (15) conducted a prospective study involving 115 patients, observing that before the use of ultrasound, the most common diagnoses made in the traditional way were congestive heart failure (41%), COPD and asthma (15). Post-ultrasound, congestive heart failure persisted as the most frequent cause of acute dyspnea (46%), but pulmonary causes decreased. 50% of healthcare workers changed their primary diagnosis with the use of bedside ultrasound ($p = 0.001$) (15). Therefore, although there are differences between the results of studies on diagnostic accuracy, depending on the entities (mainly cardiac vs. pulmonary), adding this instrument in the evaluation of acute dyspnea in the emergency department, suggests a significant increase in the predictive parameters of diagnostic accuracy, in a time that would favor the triage and mobilization of patients to the corresponding clinical departments.

In resource-limited countries, the use of bedside ultrasound changes the main diagnosis associated with acute dyspnea in more than 60% of cases,

the most frequent being acute decompensated heart failure and pneumonia (16). The diagnostic accuracy of these two diseases increases by more than 100% in both cases (53.8% to 100% for heart failure and 38% to 85.7% for pneumonia); as it does for extrapulmonary tuberculosis (14.2% to 85.7%). The study concluded that physicians' diagnostic confidence increased by up to 50% ($p < 0.001$) (16). On the basis of these results, the wide use of bedside ultrasound in internal medicine departments for dyspnea assessment has been suggested (17); and even mixed protocols such as SEARCH 8E have been proposed (Sonographic Evaluation of Aetiology of Respiratory difficulty, Chest pain and Hypotension using 8E), where the following characteristics are evaluated: Empty thorax, Edematous or wet lung, E-FAST, Effusion (pericardial), Equality (right ventricle dysfunction), Ejection fraction (left ventricle dysfunction), Exit and entrance, and Endocardial movement. This protocol has a performance with sensitivity, specificity, positive and negative predictive value parameters above 95% (18).

The available cohort studies, in contrast to the results of cross-sectional studies, show that the performance of bedside ultrasound is superior in cases where other tools were thought to be better, as in the case of pneumonia diagnosis (86% accuracy) (19). Similarly, it has been shown that there are no significant differences between the diagnostic accuracy of ultrasounds performed by primary care teams vs. radiology teams, allowing for a reduction in the burden of disease and costs of acute dyspnea management in the emergency department (20). The evidence is still heterogeneous due to the limitations of the studies, especially in terms of sample size, the way in which variables are measured, outcomes and the number of studies (19-21). Even so, the results of observational studies suggest that bedside ultrasound has the potential for very useful accuracy in the management of acute dyspnea.

Clinical trials

During the literature review, two clinical trials were found (22,23). In contrast to the observational studies, the trials did not demonstrate superiority of bedside ultrasound compared to the standard approach to acute dyspnea by clinical examination or other tools.

Gaber et al. (22) conducted a randomized clinical trial involving 59 patients. The gold standard used to compare the performance of bedside ultrasound was the diagnosis performed by two experienced senior physicians. On average, patients were middle-aged adults and mostly men. The most common definitive diagnoses were decompensated heart failure with reduced ejection fraction and exacerbations of airway diseases (asthma and COPD) (22). Compared to ultrasound, the standard test had better diagnostic

accuracy (76% vs. 79%). However, diagnosis was much faster with ultrasound (200% faster; $p < 0.001$) (22). Pang et al. (23) conducted a pilot clinical trial with 130 patients with dyspnea associated with acute heart failure, who received ultrasound-guided management for 6 hours and follow-up for up to 3 months after discharge. The authors did not find significant changes in B-lines ≤15 at 6 hours, nor in days alive at hospital discharge. They only found a reduction of B-lines at 48 hours, in the group evaluated with ultrasound ($p = 0.04$) (23).

Unfortunately, the number of clinical trials is very limited and the total sample does not exceed 200 patients. Similarly, the objective of the two trials was not the same and the outcomes varied greatly. The comparison variable (or gold standard) to ultrasound was not a diagnostic tool of falsifiable or reproducible reliability (senior physician experience), so the evidence from the highest level of primary data on the use of bedside ultrasound in the evaluation of acute dyspnea is severely biased and of low quality. This is one of the points to highlight regarding the limitations of the recommendations given by some guides or experts, based on the available evidence. In addition, almost all the studies are from high-income countries, so the performance of this tool in the context of low- and middle-income countries is not known.

Systematic reviews and meta-analysis

During the literature review, we found one systematic review (24) and one systematic review with meta-analysis (25) (Table 2). Overall, both reviews concluded that bedside ultrasound promotes the diagnostic accuracy of acute dyspnea in the emergency department.

Table 2. Summary of the characteristics of the included clinical trials and systematic reviews on use of bedside ultrasound in the evaluation of acute dyspnea (22-25)

Authors	Objective	Methods	Results	Conclusions
Gaber et al. (22)	To perform a randomized, standard therapy controlled evaluation of the diagnostic accuracy and temporal impact of a standardized ultrasound strategy, versus standard care, in patients presenting to the emergency department with acute dyspnea.	Parallel, block randomized, standard therapy controlled, blinded trial on evaluation of a point-of-care ultrasound strategy in adult emergency department patients presenting with a chief complaint of shortness of breath.	59 patients were enrolled. The most common gold standard diagnosis was acute heart failure with reduced ejection fraction in 13 (28.3%) patients and airway diseases such as acute exacerbation of asthma or chronic obstructive pulmonary disease in 10 (21.7%). Compared with the standard care cohort, the final diagnosis was obtained much faster in the ultrasound cohort (MD 12 ± 3.2 minutes vs. 270 minutes, $p < 0.001$).	A standardized ultrasound approach is equally accurate, but enables faster emergency department diagnosis of acute dyspnea than standard care.

Pang et al. (23)	To determine whether a 6-hour lung ultrasound-guided strategy-of-care improves pulmonary congestion over usual management in the emergency department setting.	Multicenter, single-blind, pilot trial randomized involving 130 patients to receive a 6-hour lung ultrasound-guided treatment strategy versus structured usual care. Patients were followed up throughout hospitalization and 90 days' postdischarge.	No significant difference in the proportion of patients with B-lines ≤15 at 6 hours (25.0% lung ultrasound vs. 27.5% usual care; p = 0.83) or the number of B-lines at 6 hours (35.4 ± 26.8 lung ultrasound vs 34.3 ± 26.2 usual care; p = 0.82) was observed between groups. A significantly greater reduction in the number of B-lines was observed in lung ultrasound -guided patients compared with those receiving usual structured care during the first 48 hours (p = 0.04).	Emergency department use of lung PoCUS to target pulmonary congestion conferred no benefit compared with usual care in reducing the number of B-lines at 6 hours or in 30 days days alive and out of hospital. However, PoCUS -guided patients had faster resolution of congestion during the initial 48 hours.
Gartlehner et al. (24)	To evaluate the benefits, harms, and diagnostic test accuracy of point-of-care ultrasonography in patients with acute dyspnea.	Systematic review of randomized clinical trials and prospective cohort studies.	Point-of-care ultrasonography, when added to a standard diagnostic pathway, led to statistically significantly more correct diagnoses in patients with dyspnea than the standard diagnostic pathway alone. In-hospital mortality and length of hospital stay did not differ significantly between patients who did or did not receive PoCUS in addition to standard diagnostic tests.	Point-of-care ultrasonography can improve the correctness of diagnosis in patients with acute dyspnea.
Maw et al. (25)	To compare the accuracy of lung PoCUS with the accuracy of chest x-ray in the diagnosis of cardiogenic pulmonary edema in adult patients presenting with dyspnea.	Systematic review and meta-analysis that included six prospective cohort studies, with a total of 1827 patients.	Pooled estimates for lung ultrasound were 0.88 (95% CI: 0.75-0.95) for sensitivity and 0.90 (95% CI: 0.88-0.92) for specificity. Pooled estimates for chest x-ray were 0.73 (95% CI: 0.70-0.76) for sensitivity and 0.90 (95% CI: 0.75-0.97) for specificity. The relative sensitivity ratio of lung ultrasound, compared with chest x-ray, was 1.2 (95% CI: 1.08-1.34; p < 0.001).	The findings suggest that lung PoCUS is more sensitive than chest x-ray in detecting pulmonary edema in acute decompensated heart failure; lung PoCUS should be considered as an adjunct imaging modality in the evaluation of patients with dyspnea at risk of acute decompensated heart failure.

Gartlehner et al. (24) synthesized evidence in a systematic way, where they evaluated clinical trials and cohort studies, concluding in a clinical practice guideline report. The authors performed an analysis by outcome, where they showed that although the synthesized studies had a high risk of bias, in-hospital mortality is similar both in the groups where bedside ultrasound was used, compared to those evaluated with standard diagnostic means (5.1% vs. 6.6%). The same trend was observed when evaluating hospital stay (2.9 days vs. 3.1 days) and 30-day readmission (23% vs. 26%) (24). Compared to other tools such as radiography or tomography, which transmit radiation, ultrasound has not reported any side or adverse effects. The diagnostic accuracy and time to definitive diagnosis is very similar to that reported in observational studies and clinical trials (accuracy above 90% and time of about 10 minutes). However, in conclusion, in conjunction with the authors' recommendations, they suggest that bedside ultrasound be complementary to traditional assessment in order to increase its positive predictive value (24).

Similarly, Maw et al. (25) performed a meta-analysis of the diagnostic accuracy of bedside ultrasound in adults with symptoms suggestive of acute decompensated heart failure, including a total of 1827 individuals. The authors found that the predictive parameter performance of bedside ultrasound in the assessment of acute heart failure was above 85%, with a slight superiority compared to chest radiography ($p < 0.001$), but no significant difference in specificity ($p = 0.96$) (25). In this order of ideas, the highest level evidence suggests that this tool is useful in the detection of fluid in the lung parenchyma, pleural space or other intrathoracic structures, although it presents a high risk of bias due to studies with heterogeneous objectives and a limited sample size. The outcome appears to be generally favorable and reproducible in the emergency department, although the overall performance in the management of dyspnea of any cause is uncertain.

FUTURE PERSPECTIVES

Wang et al. (26) analyzed through a bibliometric study the trend of the global scientific publication on the use of bedside ultrasound at a global level, finding that the United States is the country with the highest productivity, visibility and impact on this subject; pulmonary embolism being the disease most frequently studied with this tool. It is believed that the tendency is for these publications to increase, according to the reproducibility of similar studies in other regions (26).

In particular, it was observed that there are high-risk events where the impact of this tool on morbidity, costs and survival has not been studied, such as lung injury secondary to traumatic brain injury, ventilation alteration due to metabolic

causes or tumors, among others (27-29). Almost all the studies come from high-income countries, where the conditions of health services and academic preparation are of better quality (30), so it can be deduced that the external validity of the results is not very reliable, especially because a considerable volume of studies use ultrasonography as a gold standard comparator, experienced senior physicians.

A change should be initiated in the curricula of medical schools, so that undergraduate students have access to training in portable imaging tools that help them in the general approach to the patient with acute dyspnea, especially in primary care centers or low level of complexity (31). One of the objectives of global health today is to substantially promote quality and cost control in health, so bedside ultrasound would be a tool that would contribute to the fulfillment of this objective (32,33). It is postulated as a line of research of interest in internal medicine and surgery, where it has been seen how the eco-fast in trauma has changed the paradigm in the treatment of the polytraumatized patient. This is a low-cost instrument compared to other tools such as computerized tomography and magnetic resonance imaging, does not emit radiation and can be easily moved. To improve the statistical power and reliability of results, primary studies of the highest quality with representative samples and homogeneous objectives are needed.

CONCLUSIONS

The current evidence on the use of bedside ultrasound in the management of patients with acute dyspnea in the emergency department is limited, there are not enough studies, and those that do exist have a high risk of bias. Although the level of evidence is not the best, it suggests that this tool may promote the diagnostic perfomance of acute dyspnea of pulmonary or cardiac causes, improve the time to diagnosis, and enhance physician diagnostic confidence.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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