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Original Research Article

UTILITY OF POCUS IN THE EARLY DIAGNOSIS OF CARDIOPULMONARY DISORDER IN PATIENTS PRESENTING WITH ACUTE DYSPNEA: A COMPARATIVE STUDY IN A TERTIARY CARE HOSPITAL

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ABSTRACT

Background: Acute dyspnea is a common emergency presentation with multiple cardiopulmonary causes requiring prompt etiological diagnosis. Conventional evaluation relies on chest X-ray, echocardiography, and CT chest, which may delay early decision-making. Point-of-care ultrasound (PoCUS) provides bedside imaging and may assist in early identification of the underlying cause of dyspnea in emergency settings.

Materials and Methods: An analytical cross-sectional study was conducted over 12 months in the emergency department of a tertiary care centre. Adults (>18 years) presenting with acute dyspnea were included (n = 38). All patients underwent clinical assessments, routine investigations, and bedside PoCUS using the BLUE protocol. PoCUS diagnoses were compared with CT chest and transthoracic echocardiography. Sensitivity, specificity, PPV, NPV, and ROC analysis were calculated using SPSS version 31.

Results: Among participants, 63.2% were aged 20–64 years with equal gender distribution. B-lines were present in 20 patients (52.6%) and pleural effusion in 8 (21.1%). PoCUS identified pulmonary oedema/interstitial syndrome in 11 (28.9%), pneumonia in 9 (23.7%), and heart failure in 7 (18.4%). Concordance with reference imaging was 78.9%. Diagnostic performance showed sensitivity 86.7%, specificity 25%, PPV 81.3%, NPV 33.3%, and AUC 0.558 (95% CI: 0.323, 0.794; p = 0.616). Mean time to diagnosis was 13.03 ± 4.629 minutes with PoCUS versus 131 ± 67.657 minutes with reference methods (p < 0.001).

Conclusion: PoCUS enabled early identification of major cardiopulmonary causes of acute dyspnea and reduced time to diagnosis, although specificity and overall diagnostic accuracy were lower than CT chest and echocardiography.

Clinical Significance: Bedside PoCUS allows faster initial assessment and early treatment initiation in acute dyspnea patients, especially in high-volume emergency departments, while serving as an adjunct to conventional imaging methods rather than a standalone diagnostic tool.

Keywords: Dyspnea, Point-of-Care Systems, Ultrasonography, Emergency Service, Diagnostic Imaging.

INTRODUCTION

Dyspnea is a symptom with diverse causes, including respiratory, cardiac, neuromuscular, psychogenic, and systemic conditions. Respiratory causes include asthma, COPD, pneumonia, and pulmonary embolism, while cardiac causes include heart failure and pulmonary oedema. Neuromuscular disorders, psychogenic conditions, anaemia, metabolic acidosis, and sepsis can also contribute to breathlessness.[1,2] Dyspnea develops from interactions between the central nervous system and peripheral receptors regulating respiration. The medulla and pons control breathing rhythm, while lung mechanoreceptors provide feedback on lung volume. Peripheral chemoreceptors in the carotid and aortic bodies detect oxygen levels, and central chemoreceptors respond to pH changes related to carbon dioxide. These integrated signals adjust respiratory rate and depth to maintain adequate ventilation, gas exchange, and physiological balance.[3,4]

Evaluation of dyspnea starts with rapid assessment of airway, breathing, and circulation, followed by detailed history and physical examination after stabilisation. Vital signs such as heart rate, respiratory rate, temperature, BMI, and oxygen saturation provide initial clinical clues. Chest X-ray (CXR) is the primary investigation for cardiac and pulmonary causes, with abnormal findings requiring an electrocardiogram (ECG) and echocardiography. Elevated pro-BNP suggests heart failure. If chest X-rays are normal, spirometry helps identify obstructive or restrictive lung disease. Arterial blood gas (ABG) analysis assesses hypoxia and acid-base status, while further tests like V/Q scan, CT, and CBC help rule out pulmonary embolism, anaemia, and other systemic causes.[5,6]

Patients presenting to the emergency department with acute dyspnea often have a poor prognosis and a higher risk of adverse outcomes during hospitalisation and after discharge. Early diagnosis and timely treatment are essential to improve outcomes, reduce mortality, and shorten hospital stay. Establishing a differential diagnosis and initiating appropriate therapy is still clinically challenging.[1,7] A review made by Sunjaya et al. suggests that in-depth history taking, physical examination, and laboratory tests, such as full blood count and using diagnostic tools such as spirometry, CXR, and ECG, can determine the cause of dyspnea (>30%).[8]

Ultrasonography (USG) has been used in clinical practice for over 50 years. Its early use in emergency departments was limited by the consultative approach and challenges in diagnosing respiratory disorders due to imaging artefacts. The use of lung ultrasound in critically ill patients is well-established for diagnosing acute respiratory failure, undifferentiated hypotension, and guiding treatments like fluid therapy. Protocols such as BLUE, RUSH, and FALLS have proven effective. Emergency echocardiography, performed by emergency physicians, provides useful information in patients with acute dyspnea, with an overall accuracy of 97.5%.[8-10]

The differentiation between cardiovascular and pulmonary pathologies, as well as distinguishing between specific pulmonary conditions, remains an area yet to be fully explored. Point-of-care ultrasound (PoCUS) is commonly used in acute patient management, including acute dyspnea. Evidence shows PoCUS accuracy is comparable to chest X-rays in conditions like pneumonia, heart failure, pleural effusion, pneumothorax, and pulmonary embolism. PoCUS provides advantages such as no radiation exposure and bedside imaging.[11] It can address different diagnostic questions and assist in therapy planning. Few trials have examined its impact on clinical outcomes, and the results have been inconsistent.

This study evaluates the diagnostic accuracy of PoCUS in acute dyspnea and its possible time-saving benefits in diagnosis and patient disposition compared to traditional methods in the emergency department.

Objectives

To determine the diagnostic accuracy of the index test, PoCUS in patients presenting with dyspnoea, as it will be compared to the gold standard diagnostic methods. Echocardiography and CT Chest in the emergency department at the time of admission.

To analyse the sensitivity and specificity of PoCUS for various specific conditions that will be associated with acute dyspnoea at the time of admission.

MATERIALS AND METHODS

This analytical cross-sectional study was conducted in the Emergency Department of Kovai Medical Centre and Hospital, Coimbatore, Tamil Nadu, India, over a period of 12 months. Approval from the Institutional Ethical Committee was obtained before the initiation of the study, and written informed consent was obtained from all patients.

Inclusion Criteria

Patients aged ≥18 years presenting with acute onset dyspnea were included in the study.

Exclusion Criteria

Patients with traumatic causes of dyspnea, those who were hemodynamically unstable requiring immediate life-saving intervention before ultrasound examination, and those who were unwilling to give consent were excluded from the study.

Methods

Adult patients presenting to the Emergency Department with acute dyspnea were screened for eligibility, and a total of 38 patients who fulfilled the inclusion criteria were enrolled in the study. On arrival, each patient underwent a structured clinical evaluation by the emergency physician, which included detailed history taking, recording of vital signs, and a complete systemic examination. Routine baseline investigations were performed as clinically indicated and included chest X-ray (CXR), arterial blood gas (ABG) analysis, electrocardiogram (ECG), complete blood count (CBC), and other relevant laboratory tests. Based on the initial clinical assessment and conventional investigations, the treating physician documented a provisional diagnosis. The index test consisted of PoCUS, which was performed at the bedside following the standardised BLUE protocol. Lung ultrasound assessed the presence of A-lines, B-lines, lung sliding, consolidation, pleural effusion, and other sonographic signs of cardiopulmonary pathology. Focused cardiac ultrasound was used to evaluate ventricular size and function, pericardial effusion, and inferior vena cava dynamics.

Scanning of the anterolateral thoracic regions was performed in longitudinal views with the patient in a supine or near-supine position, and posterior lung zones between the posterior axillary line. The spine was examined with the patient in a seated position whenever feasible; if not possible, a lateral decubitus position was used with due attention to patient safety. PoCUS findings were categorised into specific diagnostic patterns: pulmonary oedema (bilateral diffuse multiple B-lines), pneumonia (pleural shredding, irregular pleural line, consolidation, air bronchograms, focal interstitial syndrome). Pleural effusion (anechoic space between parietal and visceral pleura with thoracic spine sign), pulmonary embolism (multiple pleural-based lesions or absence of lung findings with right ventricular strain). Acute exacerbation of COPD/asthma (preserved A-lines with lung sliding and absence of abnormal patterns), pneumothorax (absent lung sliding, absent B-lines, absent lung pulse, and presence of lung point), and ARDS/ALI (subpleural consolidations, reduced lung sliding, pleural abnormalities, and non-homogeneous B-line distribution).

The final diagnosis was established using gold-standard investigations, namely computed tomography (CT) of the chest and formal transthoracic echocardiography, along with the overall clinical course. CT chest was used to identify parenchymal abnormalities such as pneumonia, pulmonary oedema, interstitial patterns, pleural effusion, pulmonary infarction, and pneumothorax, whereas echocardiography assessed left and right ventricular function, systolic and diastolic performance, and features of right ventricular strain suggestive of pulmonary embolism. The time taken to reach a diagnosis using PoCUS and the time required with conventional diagnostic methods were recorded and compared. Data on clinical presentation, comorbidities, laboratory parameters, imaging findings, interventions, and medications administered in the emergency department were collected using a structured proforma. PoCUS diagnoses were directly compared with gold-standard results, and concordance was documented as full, partial, or discordant.

Statistical Analysis

Data were entered in Microsoft Excel and analysed using SPSS v. 25. Continuous variables were expressed as mean ± standard deviation, and categorical variables were expressed as frequency and percentage. The time to diagnosis by PoCUS and by the gold-standard investigations was compared using the paired t-test. Receiver operating characteristic (ROC) curve analysis was performed to assess the discriminative ability of PoCUS. A p-value <0.05 was considered statistically significant.

RESULTS

In the age group, 24 (63.2%) were aged 20–64 years and 14 (36.8%) were 65–90 years, with equal gender distribution (male 19 [50%], female 19 [50%]). Previous similar episodes were reported in 12 patients (31.6%). Acute dyspnoea was the predominant symptom in 37 patients (97.4%), followed by cough (42.1%), syncope (39.5%), and chest pain (31.6%). Common comorbidities included asthma and heart failure (26.3% each), CKD (23.7%), and IHD (21.1%). Mean heart rate was 107.87 ± 23.817 bpm, respiratory rate 29.16 ± 8.235/min, SpO_2 89.63 ± 6.98%, temperature 37.7 ± 1.03°C, RBS 220.18 ± 73.789 mg/dL, and mean age 55.16 ± 19.668 years. [Table 1]

Table 1: Baseline Demographic, Clinical Characteristics, and Vital Signs of Study Participants

Variable	Category	n (%) / Mean ± SD
Age Group	20–64 years	24 (63.2%)
	65–90 years	14 (36.8%)
Gender	Male	19 (50%)
	Female	19 (50%)
Previous Similar Episodes	Yes	12 (31.6%)
	No	26 (68.4%)
Clinical Presentation	Acute Dyspnoea	37 (97.4%)
	Chest Pain	12 (31.6%)
	Cough	16 (42.1%)
	Orthopnoea	7 (18.4%)
	Syncope	15 (39.5%)
	Leg Swelling	7 (18.4%)
Comorbidities	COPD	6 (15.8%)
	Asthma	10 (26.3%)
	IHD	8 (21.1%)
	Heart Failure	10 (26.3%)
	DM	7 (18.4%)
	HTN	6 (15.8%)
	CKD	9 (23.7%)
Vital Signs	Heart rate (bpm)	107.87 ± 23.817
	Respiratory rate (breaths/min)	29.16 ± 8.235
	SpO_2 (%)	89.63 ± 6.98
	Temperature (°C)	37.7 ± 1.03

	RBS (mg/dL)	220.18 ± 73.789
	Age (years)	55.16 ± 19.668

CXR showed cardiomegaly in 9 patients (23.7%), pulmonary oedema in 7 (18.4%), pleural effusion in 5 (13.2%), and consolidation in 4 (10.5%), while 34.2% were normal. ECG was normal in 26 patients (68.4%), with AF with RVR and low voltage in 4 patients each (10.5%). ABG revealed type 1 respiratory failure in 13 (34.2%) and metabolic acidosis in 11 (28.9%). Anaemia was the most common CBC abnormality (34.2%). Pro-BNP levels were >1000 pg/ml in 10 patients (26.3%). Elevated D-dimer was seen in 13 patients (34.2%), while 28.9% had normal other lab findings. [Table 2]

Table 2: Summary of Diagnostic Investigations and Laboratory Results at Presentation

Variable	Category	n (%)
CXR	Pleural Effusion	5 (13.2%)
	Cardiomegaly	9 (23.7%)
	Consolidation	4 (10.5%)
	Pulmonary Edema	7 (18.4%)
	No Abnormalities	13 (34.2%)
ECG	AF with RVR	4 (10.5%)
	ST Changes	1 (2.6%)
	Low Voltage	4 (10.5%)
	Bundle Branch Block	3 (7.9%)
	Normal	26 (68.4%)
ABG	Metabolic Acidosis	11 (28.9%)
	Type 1 Respiratory Failure	13 (34.2%)
	Normal	14 (36.8%)
CBC	Leukocytosis	8 (21.1%)
	Anaemia	13 (34.2%)
	Polycythemia	9 (23.7%)
	Normal	8 (21.0%)
Pro-BNP	>1000 pg/ml	10 (26.3%)
	300–1000 pg/ml	8 (21.1%)
	<300 pg/ml	9 (23.7%)
	Normal	11 (28.9%)
Other Lab Findings	D-dimer Elevated	13 (34.2%)
	LFT Deranged	7 (18.4%)
	High Creatinine	7 (18.4%)
	Normal	11 (28.9%)

PoCUS detected B-lines in 20 patients (52.6%), hepatomegaly in 17 (44.7%), and pleural effusion in 8 (21.1%), with no pneumothorax or pericardial effusion observed. PoCUS diagnosis showed interstitial syndrome/pulmonary edema in 11 patients (28.9%), pneumonia in 9 (23.7%), heart failure in 7 (18.4%), normal/non-cardiopulmonary causes in 7 (18.4%), pulmonary embolism suspected in 3 (7.9%), and COPD/asthma exacerbation in 1 (2.6%). The concordance with gold standard diagnosis was 78.9%, with 10.5% partial and 10.5% discordance. [Table 3]

Table 3: PoCUS Findings, Diagnoses, and Concordance with Gold-Standard Reference

Variable	Category	n (%)
Ultrasound (PoCUS) Findings	B-lines	20 (52.6)
	Pleural Effusion	8 (21.1)
	Pneumothorax	0 (0)
	Pericardial Effusion	0 (0)
	Abdominal Free Fluid	0 (0)
	Hepatomegaly	17 (44.7)
	Splenomegaly	8 (21.1)
Diagnosis by PoCUS	Interstitial Syndrome/Pulmonary Oedema	11 (28.9)
	Pneumonia	9 (23.7)
	Heart Failure with Low EF	7 (18.4)
	Normal/Non-cardiopulmonary	7 (18.4)
	Pulmonary Embolism Suspected	3 (7.9)
	COPD/Asthma Exacerbation	1 (2.6)
Concordance with Gold Standard	Concordant	30 (78.9)
	Partially Concordant	4 (10.5)
	Discordant	4 (10.5)

PoCUS demonstrated a sensitivity of 86.7%, specificity of 25%, positive predictive value (PPV) of 81.3%, and negative predictive value (NPV) of 33.3%. The ROC analysis showed an AUC of 0.558 (SE = 0.12, p = 0.616; 95% CI: 0.323–0.794). [Table 4 and Figure 4]

Table 4: Diagnostic Accuracy and ROC Analysis of PoCUS

Parameter	Value	OR (95% CI)
Sensitivity	86.70%	2.167 (0.319-14.712)
Specificity	25%	
PPV	81.30%	
NPV	33.30%	
AUC	0.558	(0.323–0.794)
Std. Error	0.12	
p-value	0.616	

Table 5: Time to Diagnosis and Management Outcomes

Parameters	Variable	Value
Comparison between PoCUS and the gold standard	Time to diagnosis by PoCUS (Mean ± SD)	13.03 ± 4.629 minutes
	Time to diagnosis by Gold Standard (Mean ± SD)	131 ± 67.657 minutes
	Mean Difference	−117.974
	SD	67.159
	p-value (2-tailed)	0
	95% CI	(−140.048 to −95.899)
Interventions	Oxygen therapy	37 (97.4%)
	Ventilation	3 (7.9%)
	Fluid management	12 (31.6%)
	IV antibiotics	14 (36.8%)
	Vasopressors	8 (21.1%)
	Bronchodilators	9 (23.7%)
	Steroids	6 (15.8%)
	Diuretics	3 (7.9%)
	Anti-coagulation	5 (13.2%)
	Antibiotics	7 (18.4%)

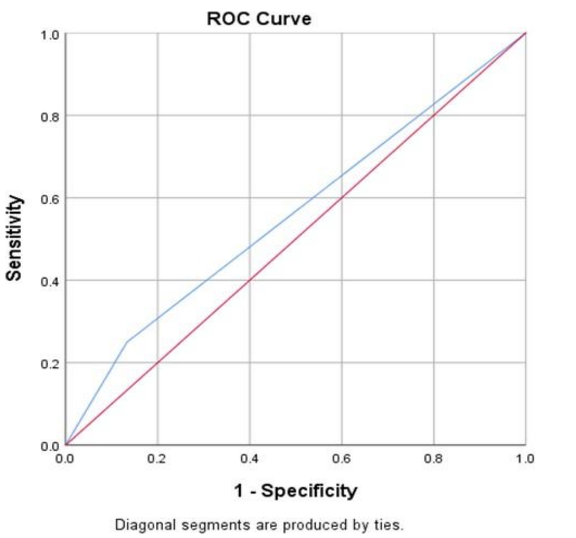

Figure 1: ROC Curve

Mean time to diagnosis by PoCUS was 13.03 ± 4.629 minutes (median 13 minutes), significantly shorter than gold standard diagnosis time of 131 ± 67.657 minutes (median 128 minutes), with a mean reduction of 117.97 minutes ($p < 0.001$). Oxygen therapy was given to 37 patients (97.4%), IV antibiotics to 14 (36.8%), fluid management to 12 (31.6%), bronchodilators to 9 (23.7%), vasopressors to 8 (21.1%), and mechanical ventilation to 3 patients (7.9%). [Table 5]

DISCUSSION

This study compared the diagnostic accuracy of PoCUS in patients presenting with acute dyspnea due to cardiopulmonary causes. PoCUS reported high sensitivity with low specificity and limited overall accuracy compared to echocardiography and CT chest. It reduced time to diagnosis in the emergency setting. Pulmonary edema, pneumonia, and heart failure were the most frequent PoCUS diagnoses, supporting its role in rapid bedside evaluation of dyspnea.

Most patients in our study were from the younger to middle age group with equal gender distribution. Acute dyspnoea was the predominant presenting complaint, followed by cough, syncope, and chest pain. Common comorbidities included asthma, heart failure, chronic kidney disease, and ischemic heart disease. Vital signs showed tachycardia, tachypnoea, hypoxia, and elevated blood glucose. Salfi et al. reported a higher mean age (61.91 ± 12.15 years) with male predominance (62.5% vs 37.5% female) among 88 dyspnea patients, and comparable prevalence of chronic kidney disease (28.4%) and coronary artery disease (45.5%), suggesting a relatively older and more comorbid population than our cohort.13 Similarly, Baid et al. reported a similar median age of 53 (18–82) years and male predominance (60% male, 40% female), with comparable tachycardia (105.78 ± 22.31 bpm), tachypnoea (26.21 ± 4.61/min), and lower oxygen saturation (83 ± 15%), along with comorbidities such as diabetes mellitus (27%), hypertension (30.8%), coronary artery disease (6.33%), and chronic kidney disease (5.49%).9 These demographic and clinical similarities and differences provide a clear background for interpreting PoCUS diagnostic performance within our study.

In our study, investigations showed common cardiopulmonary abnormalities on CXR, with many patients also having normal ECGs. ABG often indicated respiratory failure and metabolic acidosis, anaemia was the most frequent CBC abnormality, and elevated Pro-BNP and D-dimer were noted in several patients. Similarly, Baid et al., reported frequent lung ultrasound abnormalities such as irregular pleura (66.24%), pleural shredding (55.70%), diffuse and grouped B-lines (29.96% and 29.54%), and pleural effusion (unilateral 5.91%, bilateral 8.12%), along with cardiac findings like reduced ejection fraction (5.91%) and pericardial effusion (1.28%). It also showed substantial ultrasound detection of pneumonia (167 vs 188 final diagnoses), pulmonary oedema (37 vs 35), and pleural effusion (21 vs 16). They reported that infection, fluid overload, and effusion were common causes of acute dyspnea.9 These results suggest that in fluid overload, infections, and effusion are common overlapping causes in patients presenting with acute dyspnea.

The most common PoCUS diagnoses were pulmonary oedema, pneumonia, and heart failure, followed by non-cardiopulmonary causes and suspected pulmonary embolism. Similarly, Baid et al. reported PoCUS concordance (κ = 0.668) with high agreement for pulmonary oedema (κ = 0.836) and pleural effusion (κ = 0.854).9 O'Brien reported high PoCUS accuracy (94.0–98.4%) and strong concordance with final diagnoses (κ = 0.84).[14] Hence, PoCUS showed good agreement with final diagnoses, particularly for pulmonary oedema and pleural effusion, across the studies.

In our study, PoCUS showed high sensitivity but low specificity, with good positive predictive value and low negative predictive value. ROC analysis indicated poor discriminative ability and limited overall diagnostic accuracy compared to the gold standard. Similarly, Gundersen et al. reported higher diagnostic accuracy of prehospital ultrasound with an AUC of 0.85, sensitivity of 94%, and specificity of 77% for identifying the cause of dyspnea.[15] In another study by O'Brien et al., reported high diagnostic accuracy of PoCUS with sensitivity of 80.0 − 88.1%, specificity of 96.2–99.1%, PPV of 76.9–92.9%, NPV of 95.6–97.8%, and overall accuracy of 94.0–96.8% across dyspnea etiologies.[14] Similarly, Yousef et al. reported that POCUS showed high diagnostic performance across respiratory conditions: 100% sensitivity, specificity, and accuracy for interstitial lung disease and pleural effusion; 96.3% sensitivity, 90.4% specificity, and 92.4% accuracy for pneumonia; and 91.3% sensitivity, 96.4% specificity, and 94.9% accuracy for COPD or asthma exacerbation. Sensitivity was slightly lower for pneumothorax and pulmonary oedema, but specificity remained high (98.6% and 100%) with accuracies of 97% and 91%. Radiological findings were consistent with POCUS in 97.7% of patients.[16] Though previous studies have reported higher specificity and accuracy, our findings indicate that PoCUS is useful as an early screening and rule-in bedside tool rather than a definitive diagnostic modality, and should be interpreted alongside standard imaging.

In our study, PoCUS had reduced the time to diagnosis compared to gold standard methods. Most patients received oxygen therapy, while a smaller proportion required ventilation, antibiotics, fluid management, vasopressors, bronchodilators, steroids, diuretics, and anticoagulation based on clinical needs. Similar to Ciumanghel et al., who reported the median time to diagnosis using PoC-LUS by emergency physicians was 16 ± 4 minutes compared to 480 ± 112 minutes for the attending physician's diagnosis, including thoracic CT scan.[17] Yousef et al. reported the mean time to diagnose was shorter with POCUS (16 ± 6.7 min; range = 5–30 min) compared to radiography (83.6 ± 39.4 min; range = 35–200 min).16 These findings suggest that PoCUS serves as a rapid and efficient bedside diagnostic tool, by reducing the time to diagnosis compared to conventional imaging modalities.

Strengths of the study include the prospective design, use of echocardiography and CT chest as reference standards, and bedside PoCUS assessment in emergency dyspnea patients. Limitations include a single-centre setting and low specificity affecting diagnostic discrimination.

CONCLUSION

This study assessed PoCUS in patients presenting to the ED with acute dyspnea. PoCUS identified the primary cause in the majority of cases and showed a strong ability to detect true cardiopulmonary abnormalities. PoCUS delivered diagnoses much faster at the bedside, which allowed earlier initiation of treatment. In high-volume emergency departments, PoCUS can serve as a valuable initial tool, though it should be used alongside conventional imaging rather than in isolation. Further research in larger cohorts will better define its role in standard practice.

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