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Original Research Article

ROLE OF EMERGENCY PHYSICIAN–PERFORMED POINT-OF-CARE ULTRASOUND IN THE EARLY DIAGNOSIS OF ACUTE BREATHLESSNESS: A PROSPECTIVE OBSERVATIONAL STUDY

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ABSTRACT

Background: Acute onset breathlessness is one of the commonest presenting complaints in the ED and carries a broad differential spanning cardiac, pulmonary, and other systemic causes. POCUS, performed at the bedside by the treating emergency physician, has emerged as a rapid adjunct to clinical assessment. The study aims to determine the diagnostic accuracy of POCUS performed by emergency physicians in patients presenting with acute onset breathlessness to the emergency department of a tertiary care hospital.

Materials and Methods: This prospective observational diagnostic accuracy study was conducted over two years (March 2024–March 2026) in the emergency medicine department of tertiary care hospital of Pune. Adults (>18 years) presenting with acute onset breathlessness were enrolled. After initial stabilization and clinical assessment, POCUS examination including lung ultrasound, focused cardiac ultrasound, IVC assessment, and deep venous ultrasound was performed by trained emergency physicians. Findings were compared against a composite diagnosis established by two independent emergency physicians after review of investigations, supplemented by radiologist and cardiologist opinion where relevant. Data were analysed using SPSS version 29.0, with a p-value <0.05 considered significant.

Results: Of the patients analysed, 63.29% were male and 36.71% female; 21.74% had a smoking history. POCUS-diagnosed LV dysfunction showed a sensitivity of 81.82%, specificity of 0.00%, PPV of 75.00%, NPV of 0%, and overall accuracy of 64.29%. POCUS-diagnosed pneumonia showed a sensitivity of 90.48%, specificity of 0.00%, PPV of 95.00%, NPV of 0%, and accuracy of 86.36%. All patients diagnosed by POCUS with acute coronary syndrome (n=20) and acute cardiogenic pulmonary edema (n=21) were concordant with the final composite diagnosis. The most frequently and correctly diagnosed conditions were acute cardiogenic pulmonary edema (13.04%), acute coronary syndrome (12.42%), and pneumonia (11.18%). POCUS findings prompted early time-critical interventions, including needle decompression for tension pneumothorax, intercostal drain insertion for pneumothorax and hemothorax, emergency pleural tapping for pleural effusion, thrombolysis for pulmonary embolism, and expedited catheterization laboratory transfer for aortic dissection and cardiac tamponade.

Conclusion: POCUS performed by emergency physicians demonstrated high sensitivity and good overall diagnostic accuracy for common causes of acute breathlessness, particularly pneumonia, acute coronary syndrome, and acute cardiogenic pulmonary edema, and facilitated earlier initiation of life-saving interventions.

Keywords: Point-of-care ultrasound; POCUS; emergency department; acute breathlessness; diagnostic accuracy; composite diagnosis; lung ultrasound; echocardiography

INTRODUCTION

Acute onset breathlessness is one of the commonest and life-threatening presentations in emergency departments (EDs), accounting for a significant proportion of hospital admissions and early clinical deterioration. To direct prompt interventions and enhance results, it is crucial to quickly identify the underlying etiology, whether it be cardiac, pulmonary, or mixed. Conventional diagnostic pathways rely on clinical examination, chest radiography, electrocardiography, arterial blood gases, and biomarkers. However, in the early ED phase, these approaches frequently have poor accuracy, time delays, and diagnostic limitations, particularly when dealing with unstable patients.[1,2]

As emergency care continues to evolve, point-of-care ultrasound (POCUS) has emerged as a critical adjunct that addresses many of these diagnostic gaps. By providing a quick, radiation-free, bedside modality that can integrate lung, cardiac, and inferior vena cava (IVC) assessment, POCUS has revolutionized the assessment of acute dyspnea over the last ten years. The seminal BLUE protocol introduced by Lichtenstein and Mezière demonstrated that lung ultrasound signs such as A-lines, B-lines, lung sliding, consolidation, and pleural effusion could differentiate major causes of acute respiratory failure with an accuracy approaching 90%, outperforming clinical examination and chest radiography.[3] Later research showed that lung ultrasound is highly sensitive for conditions like pneumonia, pulmonary edema, and pneumothorax and provides superior diagnostic reliability compared with traditional imaging during initial ED evaluation.[4,5] By quickly differentiating between cardiogenic and non-cardiogenic dyspnea, multi-organ POCUS techniques, such as focused cardiac ultrasound and IVC evaluation, further improve diagnostic accuracy.[6]

The usefulness of POCUS as an initial assessment tool for undifferentiated dyspnoea is further supported by recent diagnostic accuracy studies. When used by qualified emergency physicians, POCUS has been shown to have high sensitivity and specificity for the diagnosis of pulmonary edema, pneumonia, pleural effusion, and obstructive airway diseases.[7] More recent research highlights its value in assessing presentations of combined chest pain and dyspnea, allowing for the prompt identification of critical conditions like pericardial effusion, right ventricular strain, and acute heart failure.[8]

POCUS has demonstrated substantial impact by altering clinical management in a significant proportion of dyspnea cases. Its capacity to deliver real-time bedside information facilitates the quick start of targeted therapy and lessens reliance on sophisticated imaging modalities.[9] The role of POCUS in enhancing diagnostic confidence, cutting down on pointless investigations, and optimizing the ED workflow is supported by randomized controlled evidence.[10]

Given this background, the present study seeks to compare the diagnostic accuracy of POCUS performed by emergency physicians with a composite diagnostic standard in adult patients presenting with acute onset breathlessness in a tertiary care ED. Establishing the reliability and diagnostic performance of POCUS in this context will help strengthen clinical decision-making frameworks and support its broader adoption in emergency medicine practice.

MATERIALS AND METHODS

A diagnostic accuracy study of prospective observational design was conducted to evaluate emergency-physician-performed POCUS against a composite reference diagnosis. The study was approved by ethics committee. The study was conducted in the Department of Emergency Medicine, Bharati Vidyapeeth (Deemed to be University) Medical College, Dhankawadi, Pune — a tertiary care teaching hospital was conducted over a period of two years, from March 2024 to March 2026. Written informed consent was taken from all patients. Adult patients aged 18 years and above with acute onset of breathlessness were included and those patients referred from outside hospitals with an already established diagnosis and pregnant patients were excluded from the study. A total 207 patients were enrolled in the study.

Data were collected using a predesigned, structured, and pretested proforma. The proforma systematically captured patient demographic details and findings pertinent to the study objectives. All data were collected prospectively at the time of patient evaluation to ensure uniformity, completeness, and accuracy. Collected data were coded and entered into a Microsoft Excel spreadsheet and subsequently analysed using Statistical Package for the Social Sciences (SPSS) version 29.0. Results were presented in tabular and graphical form to enhance clarity of interpretation. Qualitative (categorical) data were expressed as frequencies, percentages, and ratios. Quantitative data were summarised using the mean, standard deviation (SD), and median. Diagnostic performance of POCUS was expressed as sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy, using the final composite diagnosis as the reference standard. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Table 1: Demographic distribution

Gender	Frequency	Percentage
Female	76	36.71%
Male	131	63.29%
Smoking Status		
Yes	45	21.74%
No	162	78.26%

Of the study population, 131 patients (63.29%) were male and 76 (36.71%) were female. A history of smoking was present in 45 patients (21.74%), while 162 patients (78.26%) were non-smokers [Table 1].

Diagnostic Performance of POCUS

Table 2: LV dysfunction diagnosed by the EMD physician and the final composite diagnosis

LV dysfunction Diagnosis by EMD physician		Final Composite Diagnosis	
		Yes	No
	Yes	9	3
	No	2	0

Among patients diagnosed with LV dysfunction by the EMD physician, 9 were confirmed positive and 3 were negative on the final composite diagnosis. Among those not diagnosed with LV dysfunction by the EMD physician, 2 patients were nonetheless positive on the final composite diagnosis and none were negative [Table 2].

Diagnosed by the EMD physician and the final composite diagnosis: All 20 patients diagnosed with acute coronary syndrome by the EMD physician were also confirmed positive on the final composite diagnosis and all 21 patients diagnosed with acute cardiogenic pulmonary edema by the EMD physician were also confirmed positive on the final composite diagnosis. Among patients diagnosed with pneumonia by the EMD physician, 19 had a positive final composite diagnosis, while 1 did not. Among those not diagnosed with pneumonia by the EMD physician, 2 patients had a positive final composite diagnosis and none had a negative final composite diagnosis.

Table 3: Diagnostic performance of LV dysfunction and pneumonia diagnosed by the EMD physician

Test Result Variable(s)	Sensitivity	Specificity	PPV	NPV	Accuracy
LV dysfunction diagnosed by EMD physician	81.82%	0.00%	75.00%	0%	64.29%
Pneumonia diagnosed by EMD physician	90.48%	0.00%	95.00%	0%	86.36%

Sensitivity for LV dysfunction was high (81.82%), reflecting good ability to correctly identify affected patients; however, specificity was 0.00%, reflecting the absence of true-negative cases in this small subgroup rather than a true absence of discriminatory ability. Overall accuracy was 64.29%. Sensitivity for pneumonia was high (90.48%) with a PPV of 95.00% and overall accuracy of 86.36%, indicating good overall diagnostic reliability despite the limited specificity attributable to the small number of true-negative cases in this subgroup [Table 3]. POCUS performed by the emergency physician demonstrated high sensitivity (90.5%) for detecting pneumonia compared with the composite diagnosis, indicating that it identified most patients with pneumonia. However, the specificity was 0%, which reflects that there was only one patient without pneumonia in the study, and that patient was classified as positive by POCUS. Therefore, the specificity estimate is unstable and not clinically interpretable because of the extremely small number of disease-negative patients. POCUS performed by the emergency physician demonstrated a sensitivity of 81.8% and specificity of 0% for the diagnosis of left ventricular (LV) dysfunction when compared with the final composite diagnosis. The positive predictive value (PPV) was 75.0%, the negative predictive value (NPV) was 0%, and the overall diagnostic accuracy was 64.3%. The specificity estimate should be interpreted with caution because only three patients were disease-negative according to the composite diagnosis, and all three were classified as positive by POCUS, resulting in a specificity of 0%. Thus, the small number of disease-negative cases makes the specificity estimate unstable

Spectrum of Correctly Diagnosed Conditions: Acute cardiogenic pulmonary edema was the most common correctly diagnosed condition (13.04%), followed by acute coronary syndrome (12.42%) and pneumonia (11.18%). Acute pulmonary embolism and pleural effusion were each identified in 6.21% of patients, and ARDS in 5.59%. LV dysfunction, tension pneumothorax, and unstable tachyarrhythmia were each identified in 4.97% of patients. A long tail of less frequent but clinically significant diagnoses — including aortic dissection, cardiac tamponade, dilated cardiomyopathy, and hemoperitoneum — were each identified in single patients, underscoring the breadth of pathology detectable on a focused bedside POCUS protocol.

Impact of POCUS on Timing of Life-Saving Interventions: The timing of POCUS-directed interventions was recorded at sequential time points following patient arrival. Representative findings at each time point are summarised below [Table 4].

Table 4: Emergency diagnoses and interventions recorded at different Time Point 10

	Diagnosis	Intervention	Frequency
Time Point 10	Acute coronary syndrome	Cardiac loading doses administered; patient prepared for catheterization laboratory	1
	Pneumothorax	Left-sided intercostal drain (ICD) insertion; ICU admission arranged	1
	Tension pneumothorax	Needle decompression performed in the 2nd right intercostal space	1
	Acute cardiogenic pulmonary edema	Non-invasive ventilation (NIV) initiated with inopressor support (noradrenaline)	1
	Acute coronary syndrome	Oxygen support initiated; patient shifted to catheterization laboratory	1
Time Point 15	Cardiac tamponade	Shifted to catheterization laboratory for pericardiocentesis	1
	Severe pulmonary hypertension	NIV initiated with diuretics and pulmonary vasodilator support	1
Time Point 20	Aortic dissection	Diagnosis confirmed; patient shifted to catheterization laboratory	1
	Pleural effusion	Emergency pleural tapping performed in the emergency department	1
	Pleural effusion	Ultrasound-guided pleural tapping performed (right side)	1
	Acute pulmonary edema	Diuretics administered; emergency right-sided pleural tapping performed	1
	Cardiac tamponade (impending)	Impending tamponade identified; pericardiocentesis deferred	1
	Tension pneumothorax	Initial needle decompression followed by ICD insertion	1
	Hemothorax	Left-sided ICD insertion; massive transfusion protocol (MTP) activated	2
	Pleural effusion	Oxygen support with right-sided pleural tapping	1
	Pleural effusion	Pleural tapping performed as emergency intervention	1
	Cardiac tamponade	Shifted to catheterization laboratory for pericardiocentesis	1
	Pulmonary embolism	Diagnosis confirmed; thrombolysis administered	2
	Pneumothorax	ICD insertion in the right 5th intercostal space	3
	Tension pneumothorax	Needle decompression followed by right-sided ICD insertion; ICU admission	2

At 10 time point, acute coronary syndrome was the most frequent diagnosis (n=2), managed with cardiac loading doses and expedited catheterization laboratory referral. Tension pneumothorax was managed with emergency needle decompression, pneumothorax with intercostal drain insertion, and acute cardiogenic pulmonary edema with NIV and inopressor support. At 15 time point, Cardiac tamponade identified on POCUS was managed with prompt transfer for pericardiocentesis, while severe pulmonary hypertension was managed with NIV, diuretics, and vasodilator support. By 20 time point, pleural effusion (n=4) was the most frequently managed condition, addressed with emergency (including ultrasound-guided) pleural tapping. Pneumothorax (n=3) was managed with ICD insertion, tension pneumothorax (n=2) with needle decompression followed by ICD insertion, pulmonary embolism (n=2) with thrombolysis, and hemothorax (n=2) with ICD insertion and MTP activation. Single, high-acuity diagnoses — aortic dissection and cardiac tamponade — were managed with expedited catheterization laboratory transfer [Table 4].

POCUS findings were directly and repeatedly linked to time-critical bedside and procedural interventions — needle decompression, ICD insertion, pericardiocentesis referral, pleural tapping, thrombolysis, and catheterization laboratory activation — occurring within a short interval of patient presentation, consistent with a meaningful reduction in time to life-saving intervention when POCUS was incorporated into the initial emergency assessment.

DISCUSSION

This study evaluated the diagnostic accuracy of a focused, multi-organ POCUS protocol performed by emergency physicians in patients presenting with acute onset breathlessness, using a rigorously derived composite diagnosis as the reference standard. The findings suggest that bedside POCUS, when performed by trained and privileged emergency physicians, can identify a broad spectrum of cardiac, pulmonary, and vascular causes of breathlessness with high sensitivity, and can meaningfully expedite time-critical interventions.

The present study identified pneumonia (11.18%) and acute pulmonary edema (13.04%) as among the most frequently diagnosed conditions, consistent with the findings of Buhumaid et al,[13] in which these etiologies were commonly encountered among patients presenting with acute dyspnea. Similarly, O'Brien et al,[12] reported a comparable prevalence of heart failure (12.8%). In contrast, Ciumanghel et al,[13] observed a lower prevalence of ARDS (1.9%) compared with 5.59% in the present study, whereas Baid et al,[7] reported a substantially higher prevalence of pneumonia (79.32%). These differences likely reflect variations in patient populations, referral patterns, and regional disease epidemiology, highlighting the heterogeneity in the underlying causes of acute dyspnea across different healthcare settings.

The present study demonstrated association between LV dysfunction diagnosed by the EMD physician and the final composite diagnosis. A sensitivity of 81.8% in detecting LV dysfunction, which is comparable to the findings of Baid et al,[7] reporting 77.7% sensitivity in emergency department settings, indicating consistently high diagnostic performance. However, the PPV of 75% observed in the present study is lower than the 85% reported by Vauthier et al,[14] who utilized a more stringent multi-parametric echocardiographic approach. These findings suggest that while emergency physician assessment demonstrates good sensitivity, there remains scope for enhancing diagnostic accuracy and reducing false-positive rates through the incorporation of advanced and standardized sonographic protocols.

Diagnostic performance of LV dysfunction diagnosed by the EMD physician demonstrated a sensitivity of 81.82% for detecting left ventricular (LV) dysfunction, which is consistent with the findings of O’Brien et al,[12] reporting 81.25% and Baid et al,[7] reporting 77.7%, indicating comparable ability to identify true positive cases. However, the observed specificity of 0.00% and overall diagnostic accuracy of 64.29% are markedly lower than those reported by Baid et al,[7] and O’Brien et al,[12] who documented specificities of 96.9% and 99.08%, respectively. Furthermore, Vauthier et al,[14] demonstrated that the use of a multi-parametric echocardiographic algorithm could achieve a sensitivity of up to 96% along with a positive predictive value of 85%. These findings underscore the limitations in specificity and diagnostic precision in the present study and highlight the need for standardization of ultrasound training and the incorporation of advanced sonographic parameters to reduce diagnostic ambiguity and improve clinician-driven assessment.

Association between acute coronary diagnosis by the EMD physician and the final composite diagnosis demonstrated a specificity of 100% for the confirmation of acute coronary syndrome (ACS), indicating excellent diagnostic precision and aligning with the findings of Baid et al,[7] who also reported 100% specificity. However, Baid et al,[7] observed a lower sensitivity of 50%, suggesting that certain ACS cases may not exhibit clear regional wall motion abnormalities on initial assessment. Additionally, Beyer et al,[15] reported that approximately 67% of initially suspected ACS cases were later reclassified, most commonly as congestive heart failure, underscoring the diagnostic complexity of ACS. These findings highlight that while physician assessments can achieve high specificity, accurate differentiation of ACS from other cardiopulmonary conditions remains challenging and necessitates careful clinical and imaging evaluation.

Association between acute pulmonary edema (cardiogenic) diagnosed by the EMD physician and the final composite diagnosis. Demonstrated a 100% confirmation rate for acute cardiogenic pulmonary edema, reflecting excellent diagnostic agreement and aligning with the perfect agreement ($\kappa = 1.0$) and 100% specificity reported by Ciumanghel et al.[13] This level of accuracy exceeds the 81.3% sensitivity reported by O’Brien et al,[12] using a modified BLUE protocol, as well as the 97.7% specificity documented by Baid et al.[7] Furthermore, Vauthier et al,[14] reported a sensitivity of 96% with the use of structured echocardiographic algorithms for confirming cardiogenic failure. Collectively, these findings emphasize that physician-led sonographic evaluation serves as a highly reliable and definitive diagnostic tool in the assessment of acute respiratory conditions, particularly in identifying cardiogenic pulmonary edema.

Association between pneumonia diagnosed by the EMD physician and the final composite diagnosis demonstrated a pneumonia sensitivity of 90.48%, which is higher than the 80% reported by O’Brien et al,[5] and falls within the 93.3% to 100% range documented by Ciumanghel et al,[13] indicating strong capability in identifying true positive cases. However, the observed specificity of 0.00% represents a major diagnostic limitation when compared to the higher specificities reported by Ciumanghel et al,[13] (98.5%) and Baid et al,[7] (87.7%). Despite this, the positive predictive value of 95% remains notably high, suggesting that most positive diagnoses were accurate. These discrepancies underscore the need for standardized sonographic training and protocols to minimize false-positive interpretations and improve diagnostic specificity in emergency settings.

Diagnostic performance of pneumonia diagnosed by the EMD physician demonstrated a high screening efficacy with a pneumonia diagnostic sensitivity of 90.48%, which is consistent with the 93.3% to 100% range reported by Ciumanghel et al,[13] and exceeds the 80.0% sensitivity observed by O’Brien et al,[12] However, the observed specificity of 0.00% reveals a significant diagnostic limitation when compared to the higher benchmarks of 98.6% and 87.7% reported by Ciumanghel et al,[13] and Baid et al,[7] respectively. Although the positive predictive value of 95.00% remains strong, the overall diagnostic accuracy of 86.36% is notably lower than the 95.6% accuracy reported by O’Brien et al,[12] primarily due to the absence of specificity. These findings indicate that while physician assessments are highly sensitive, the lack of specificity leads to increased false-positive rates, emphasizing the need for standardized sonographic protocols, as recommended by Kizito et al,[16] to improve diagnostic precision and overall reliability.

These findings are broadly consistent with the established literature on multi-organ point-of-care ultrasound protocols in acute dyspnea and shock, which have similarly emphasised the value of integrated lung, cardiac, and IVC assessment in rapidly narrowing the differential diagnosis and guiding immediate management at the bedside.

Strengths: The principal strengths of this study include its prospective design, use of a rigorously defined composite reference standard incorporating independent physician review and specialist opinion, and its focus on both diagnostic accuracy and the clinically meaningful secondary outcome of intervention timing, which is often omitted from purely diagnostic-accuracy studies of POCUS.

Limitations: This study has several limitations. It was conducted at a single tertiary care centre, which may limit the generalisability of the findings to settings with differing case-mix, POCUS training standards, or resource availability. Subgroup sample sizes for individual diagnoses (e.g., LV dysfunction, pneumonia, acute coronary syndrome) were modest, and the resulting paucity of true-negative cases in some categories limited the precision of specificity and NPV estimates, as reflected in the 0.00% specificity values obtained for LV dysfunction and pneumonia.

CONCLUSION

Point-of-care ultrasound performed by trained emergency physicians demonstrated high sensitivity and good overall diagnostic accuracy for common and life-threatening causes of acute onset breathlessness, including pneumonia, acute coronary syndrome, acute cardiogenic pulmonary edema, and LV dysfunction, when benchmarked against a composite reference diagnosis. Beyond its diagnostic yield, POCUS was associated with earlier initiation of time-critical interventions — including needle decompression, intercostal drain insertion, pleural tapping, thrombolysis, and expedited catheterization laboratory referral — supporting its integration into the initial bedside assessment of the breathless patient in the emergency department. Given the limited precision of specificity estimates for some subgroups in this cohort, larger multi-centric studies with adequate representation of disease-negative patients across all diagnostic categories are warranted to further validate and refine these findings.

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