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Role of Ultrasonography in Adult Patients Presenting with Acute Dyspnoea at the Emergency Department of a Teaching Tertiary Care Hospital.

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Abstract

Background: Acute dyspnoea accounts for approximately 7.4% of emergency department (ED) visits and presents a diagnostic challenge owing to its diverse aetiology. Point-of-care ultrasonography (POCUS) has emerged as a rapid, non-invasive bedside tool that may improve diagnostic accuracy and expedite management. ***Objectives:*** To evaluate the usefulness of POCUS in the differential diagnosis of acute dyspnoea (primary objective) and to assess its efficacy in identifying the underlying aetiology (secondary objective). ***Methods:*** A prospective observational study was conducted over 18 months in the ED of a tertiary care hospital. Eighty-five adult patients presenting with acute dyspnoea were enrolled. A modified RADIUS (Rapid Assessment of Dyspnoea with Ultrasound) protocol including cardiac, lung, IVC, and deep-vein examination was performed by a trained emergency physician. Pre-ultrasound, post-ultrasound, and discharge diagnoses were compared. Statistical analysis was performed using SPSS v28.0. ***Results:*** Mean patient age was 60.98 ± 14.87 years. New-onset dyspnoea was present in 45 patients (52.94%) and pre-existing dyspnoea in 34 (40%). POCUS altered the initial clinical diagnosis in 43.53% of cases. Post-ultrasound diagnoses agreed with discharge diagnoses in 75.29% of cases ($p < 0.05$). Among 37 cases in which POCUS changed the pre-ultrasound diagnosis, the revised diagnosis matched the discharge diagnosis in 70.27%. Conditions most frequently missed by POCUS included bilateral pneumonia, bilateral pneumonitis, and acute asthma exacerbation. ***Conclusion:*** POCUS is a valuable tool for rapid assessment of acute dyspnoea in the ED, significantly improving diagnostic accuracy and facilitating early management decisions. It should complement, rather than replace, clinical evaluation and other diagnostic modalities, particularly for complex or overlapping pulmonary pathologies.

Keywords: acute dyspnoea, point-of-care ultrasonography (POCUS), emergency medicine, pulmonary oedema, pneumonia, pleural effusion, diagnostic accuracy, RADIUS protocol, lung ultrasound, India.

INTRODUCTION

Acute dyspnoea — defined as the sudden onset of difficulty in breathing developing over hours to days — is one of the most common and potentially life-threatening presentations encountered in emergency departments (EDs) worldwide. Approximately 7.4% of all ED visits are attributed to dyspnoea as the chief complaint [1–4]. The symptom arises from a broad differential that encompasses cardiovascular disorders (heart failure, pulmonary embolism, cardiac tamponade), respiratory conditions (pneumonia, pneumothorax, pleural effusion, COPD exacerbation, asthma), and metabolic or neuromuscular disturbances.

Traditional diagnostic pathways — comprising history, physical examination, chest radiography, arterial blood gas analysis, electrocardiography, and biomarkers — are often time-consuming and may delay the initiation of life-saving therapy [5–7]. Chest radiography, in particular, has well-recognised limitations in sensitivity and specificity for several important conditions, including early pulmonary oedema and small pleural effusions.

Point-of-care ultrasonography (POCUS) has emerged as a transformative tool in the ED, offering real-time, bedside imaging without the use of ionising radiation. Focused lung ultrasonography (LUS) and cardiac ultrasonography (FoCUS) have demonstrated high sensitivity and specificity for conditions such as pulmonary oedema, pneumothorax, pleural effusion, and impaired ventricular function [8–12]. Standardised protocols — including the BLUE (Bedside Lung Ultrasound in Emergency) protocol, the RUSH (Rapid Ultrasound for Shock and Hypotension) protocol, and the RADIUS (Rapid Assessment of Dyspnoea with Ultrasound) protocol — allow systematic bedside evaluation of the dyspnoeic patient [9–12].

Despite growing global evidence, the adoption of POCUS in Indian EDs remains limited, constrained by variable operator training, equipment availability, and a relative paucity of local research data. Emergency medicine is an evolving specialty in India, and studies from this context are essential to establish the utility of POCUS within the local healthcare framework [13, 14].

This study was conducted to evaluate the role of POCUS in the diagnostic assessment of adult patients presenting with acute dyspnoea in the ED of a teaching tertiary care hospital in northern India. Specific objectives were to determine the extent to which POCUS alters initial clinical diagnoses, and to assess the agreement between POCUS-based and final discharge diagnoses.

MATERIALS AND METHODS

This was a prospective observational study conducted in the Emergency Medicine Department of Yashoda Hospital and Research Centre, Nehru Nagar, Ghaziabad, Uttar Pradesh — a teaching tertiary care hospital. The study period spanned 18 months from the date of ethical approval.

Patient Selection

Inclusion criteria: Adult patients (≥18 years) presenting to the ED with acute dyspnoea.
Exclusion criteria: Patients who declined consent; pregnant women; patients younger than 18 years; patients with a known psychiatric illness; and patients with established chronic dyspnoea without an acute component.

Sample Size

Based on published diagnostic accuracy data for POCUS in acute dyspnoea (range 85–100%), a minimum sample of 85 patients was calculated using the formula $n = [Z\alpha^2 P(1-P)] / d^2$, assuming P = 85%, margin of error d = 8%, and 5% level of significance.

Ultrasound Examination Protocol

All ultrasound examinations were performed by the Chief Investigator (CI), an emergency physician trained in POCUS per international recommendations (EDE and ACEP guidelines). A Sonoscape ultrasound machine was used with both a linear high-frequency probe (6–13 MHz) and a curvilinear low-frequency probe (2.5–7.5 MHz). Twenty-five percent of saved images were reviewed for quality assurance.
The modified RADIUS protocol was applied, comprising four components:

Table 1. Modified RADIUS protocol components.

Protocol Component	Technique
Cardiac Examination	Parasternal long-axis, parasternal short-axis, apical four-chamber, and subxiphoid views: contractility, chamber size, pericardial fluid
IVC Evaluation	Subxiphoid view; diameter and respiratory variation measured; right lateral view used when subxiphoid approach was not feasible
Pleural/Thoracic Assessment	Costophrenic angles assessed for pleural effusion; lung sliding assessed at second intercostal space with linear probe
Lung Parenchyma	All eight Volpicelli lung zones examined for B-lines, A-lines, comet tails, and consolidation
DVT Assessment	Two-point (common femoral vein/GSV bifurcation and popliteal vein trifurcation) compression ultrasonography

Ultrasound findings were interpreted against validated sonographic patterns summarised in Table 2.

Table 2. Ultrasound clinical patterns and diagnostic markers.

Ultrasound Pattern	Sonographic Markers
Pleural Effusion	Anechoic areas above the diaphragm; loss of mirror-image artefact; positive spine sign
Pulmonary Oedema	>2 B-lines in >2 lung zones bilaterally
Focal Interstitial Disease	≥2 B-lines in one or more lung fields
Pneumothorax	Absent lung sliding and comet tails; presence of lung point
Pneumonia	Focal hypoechoic consolidation with air bronchograms; hepatisation pattern
COPD/Asthma	Bilateral A-lines without other pathology; preserved lung sliding
Pericardial Effusion	Circumferential anechoic space within pericardium
Cardiac Tamponade	Pericardial effusion with RV diastolic collapse
Systolic Heart Failure	Reduced LV contractility; IVC >2.5 cm with <50% respiratory variation
Pulmonary Embolism	RV dilatation with septal bowing toward LV (D-sign); DVT on leg scan

Study Procedure

Upon enrolment, the treating emergency physician independently generated a ranked list of the top three pre-ultrasound diagnoses with confidence ratings on a Likert scale (1–5). The CI then performed POCUS and communicated findings to the clinical team; post-ultrasound diagnoses and confidence scores were re-recorded. Final discharge diagnoses were retrieved from hospital records and used as the reference standard.

Statistical Analysis

Data were analysed using SPSS version 28.0. Continuous variables are presented as mean ± SD or median (IQR) for non-normally distributed data. Categorical variables are expressed as frequencies with 95% confidence intervals. The Chi-square test was used for categorical comparisons; a p-value < 0.05 was considered statistically significant.

RESULTS

Demographic and Clinical Characteristics

A total of 85 patients were enrolled. The mean age was 60.98 ± 14.87 years (median 65 years; range 18–88 years). New-onset dyspnoea was present in 45 patients (52.94%) and pre-existing dyspnoea in 34 patients (40.0%); 6 patients (7.06%) had acute-on-chronic presentations. The 61–80-year age group accounted for 54.12% of all cases and harboured the highest proportion of pre-existing dyspnoea (70.59%). New-onset dyspnoea was most frequent in the 41–60-year group (40%). No statistically significant difference in dyspnoea type was found across age groups ($\chi^2 = 10.01$, $p = 0.263$).

Table 3. Age distribution of dyspnoea patients by onset type ($\chi^2 = 10.01$, $p = 0.263$).

Age Group	New Onset n (%)	Pre-Existing n (%)	Total n (%)
0–20 years	2 (4.4%)	0 (0.0%)	2 (2.4%)
21–40 years	6 (13.3%)	2 (5.9%)	8 (9.4%)
41–60 years	18 (40.0%)	6 (17.6%)	24 (28.2%)
61–80 years	17 (37.8%)	24 (70.6%)	41 (48.2%)
>80 years	2 (4.4%)	2 (5.9%)	4 (4.7%)
Total	45 (100%)	34 (100%)	85 (100%)

Pre-Ultrasound Versus Post-Ultrasound Diagnosis

POCUS led to a change in the working diagnosis in 37 of 85 cases (43.53%), while the pre-ultrasound diagnosis was retained in 48 cases (56.47%). The difference was not statistically significant ($\chi^2 = 0.0$, $p = 1.0$), reflecting balanced distribution of matched and changed diagnoses.

Table 4. Pre-ultrasound versus post-ultrasound diagnosis comparison ($\chi^2 = 0.0$, $p = 1.0$).

Comparison	Count	Percentage
Matched diagnosis	48	56.47%
Changed diagnosis	37	43.53%
Total	85	100%

Pre-Ultrasound Versus Discharge Diagnosis

Comparing initial clinical diagnosis with the final discharge diagnosis, 55.29% of patients (n = 47) had a different discharge diagnosis from their pre-ultrasound assessment, while 44.70% (n = 38) had a matched diagnosis. This finding highlights the overall inadequacy of clinical-only pre-test assessment for a large proportion of patients ($\chi^2 = 0.0$, $p = 1.0$).

Table 5. Pre-ultrasound versus discharge diagnosis comparison ($\chi^2 = 0.0$, $p = 1.0$).

Comparison	Count	Percentage
Matched diagnosis	38	44.70%
Different diagnosis	47	55.29%
Total	85	100%

Post-Ultrasound Versus Discharge Diagnosis

Post-ultrasound diagnoses agreed with discharge diagnoses in 64 of 85 cases (75.29%). In the remaining 21 cases (24.71%), the final diagnosis differed from the POCUS-based assessment. The overall agreement demonstrates good concordance between POCUS findings and the reference standard.

Table 6. Post-ultrasound versus discharge diagnosis comparison.

Comparison	Count	Percentage
Matched diagnosis	64	75.29%
Different diagnosis	21	24.71%
Total	85	100%

Impact of POCUS on Diagnostic Change

Among the 37 cases where POCUS altered the pre-ultrasound diagnosis, the revised POCUS-based diagnosis was subsequently confirmed by the discharge diagnosis in 26 cases (70.27%), demonstrating meaningful diagnostic refinement. In 11 cases (29.72%), the POCUS-changed diagnosis did not match the final discharge diagnosis, indicating residual diagnostic uncertainty even after ultrasonography.

Table 7. Outcomes of cases where POCUS altered the pre-ultrasound diagnosis.

Outcome of POCUS-Changed Diagnoses	Count	Percentage
POCUS change confirmed at discharge	26	70.27%
POCUS change not confirmed at discharge	11	29.72%
Total cases where POCUS changed diagnosis	37	100%

Conditions Missed by POCUS

Twenty-one discharge diagnoses were not captured by post-ultrasound assessment (Table 8). Bilateral pneumonia (8 cases) and acute asthma exacerbations (3 cases) were the most frequently missed conditions, followed by bilateral pneumonitis (3 cases). Rare or complex diagnoses including diffuse alveolar haemorrhage (1 case), fungal pneumonia with bronchiectasis (1 case), and hydropneumothorax (1 case) were also not identified by POCUS alone.

Table 8. Discharge diagnoses not captured by post-ultrasound assessment.

Missed Diagnosis	Number of Cases
Bilateral pneumonia	8
Acute exacerbation of asthma	3
Bilateral pneumonitis	3
Pneumonia (unilateral)	3
Left hydropneumothorax	1
Fungal pneumonia with bronchiectasis and bilateral lung fibrosis	1
Diffuse alveolar haemorrhage	1
Acute LVF with pericardial effusion	1

Post-Ultrasound Diagnosis, Outcomes, and Statistical Significance

Of the 64 patients with matched post-ultrasound and discharge diagnoses, the majority were discharged (67.18%); 17.18% died and 4.68% were referred to a higher centre. Among the 21 patients with discordant diagnoses, 80.95% were ultimately

discharged and 4.76% died. The chi-square test demonstrated a highly statistically significant association between post-ultrasound diagnostic accuracy and patient outcomes (χ^2 p-value = 2.73×10^{-14}, $p < 0.05$).

Table 9. Post-ultrasound versus discharge diagnosis with patient outcomes ($p < 0.05$). LAMA = Left Against Medical Advice; DOPR = Discharged on Patient Request.

POCUS vs. Discharge	Discharged	Death	LAMA	Referral	DOPR	Total
Matched (n=64)	43 (67.2%)	11 (17.2%)	2 (3.1%)	3 (4.7%)	5 (7.8%)	64
Different (n=21)	17 (81.0%)	1 (4.8%)	3 (14.3%)	0 (0.0%)	0 (0.0%)	21
Total	60	12	5	3	5	85

DISCUSSION

This prospective study evaluated the diagnostic impact of POCUS in 85 adult patients presenting with acute dyspnoea to a tertiary care ED in northern India. The key finding was that POCUS altered the initial clinical impression in 43.53% of cases, and post-ultrasound diagnoses were concordant with final discharge diagnoses in 75.29% of cases — a statistically significant association ($p < 0.05$).

The proportion of diagnostic changes attributable to POCUS (43.53%) is consistent with the literature. Qaseem et al. (2021) in a clinical guideline from the American College of Physicians reported that POCUS routinely alters initial diagnoses in dyspnoeic ED patients, leading to more appropriate early management [14]. Similarly, Zanobetti et al. (2017) found that POCUS refined initial diagnoses and improved outcomes in a multi-centre ED study [15]. Our finding that 70.27% of POCUS-changed diagnoses were ultimately confirmed at discharge is particularly noteworthy, underscoring the tool's capacity to enhance bedside clinical reasoning.

The 75.29% agreement between post-ultrasound and discharge diagnoses compares favourably with findings from Baid et al. (2022), who demonstrated strong concordance between POCUS-based and final diagnoses in a large Indian tertiary care ED cohort [18], and with Pirozzi et al. (2014), who showed that integrated POCUS significantly reduced time to correct diagnosis [19]. In the present study, Zare et al. (2022) and Umuhire et al. (2019) provide additional cross-contextual validation, with both studies demonstrating that POCUS reliably modifies diagnoses in resource-limited settings comparable to those in India [16, 17].

The conditions most frequently missed by POCUS — bilateral pneumonia (n=8), bilateral pneumonitis (n=3), and acute asthma exacerbations (n=3) — are well-recognised limitations of lung ultrasonography. Bilateral alveolar consolidations can be difficult to distinguish sonographically from bilateral interstitial patterns, and asthma exacerbations typically produce only non-specific A-line profiles indistinguishable from normal aerated lung on POCUS. These findings are in accord with Whitson and Mayo (2016) [20] and Gallard et al. (2015) [21], who similarly noted that POCUS sensitivity is attenuated for diffuse or bilateral parenchymal infections and obstructive airway disease.

The significant difference in outcomes between patients with matched versus discordant post-ultrasound diagnoses (χ^2 p = 2.73×10^{-14}) suggests that greater POCUS diagnostic concordance is associated with better-informed clinical management. Although causality cannot be inferred from this observational design, patients in the matched group had a mortality rate of 17.18% versus 4.76% in the discordant group — the higher mortality in the matched group likely reflects that correctly identified severe conditions (e.g. acute LVF with low ejection fraction, ARDS) were more frequently captured by POCUS and represent inherently higher-acuity presentations.

The demographic profile of our cohort — mean age nearly 61 years, predominance of pre-existing dyspnoea in those aged 61–80 — mirrors the global burden of dyspnoea, where older patients with multimorbidity carry the greatest risk [22, 23]. This contextual factor supports the value of integrating POCUS into standard triage pathways for older dyspnoeic patients. The RADIUS protocol adopted in this study incorporates a broader multi-organ assessment than BLUE alone, including IVC and DVT evaluation, which is particularly suited to undifferentiated dyspnoea where cardiac, venous thromboembolic, and pulmonary aetiologies must be simultaneously considered. The DVT component enabled the identification of two cases of pulmonary embolism where leg ultrasonography confirmed the diagnosis, consistent with the BLUE protocol's reported 81% sensitivity for PE [24].

This study adds to the growing body of evidence supporting POCUS integration in Indian EDs, where formal POCUS training programmes remain limited [25]. Given the resource constraints common to many Indian hospitals, POCUS offers a low-cost, radiation-free, immediately available diagnostic adjunct that can shorten the time to definitive diagnosis.

LIMITATIONS

Several limitations should be considered when interpreting these findings. First, this was a single-centre study conducted primarily during daytime hours when the trained CI was present, introducing selection bias; night-time or weekend presentations were not systematically captured. Second, image acquisition and interpretation were performed by a single operator, preventing assessment of inter-rater reliability. Third, with 85 patients, the study is underpowered for condition-specific sensitivity and specificity analyses. Fourth, only in-hospital outcomes up to discharge were assessed; long-term outcomes were not evaluated. Finally, the absence of blinding between the treating team and POCUS operator may have introduced knowledge bias in the recording of post-ultrasound diagnoses.

CONCLUSION

Point-of-care ultrasonography is a clinically valuable and feasible diagnostic tool for the rapid assessment of acute dyspnoea in the emergency department. In this prospective cohort, POCUS modified the initial clinical diagnosis in 43.53% of cases and demonstrated 75.29% agreement with final discharge diagnoses. In over two-thirds of cases where POCUS changed the working diagnosis, the revised assessment was ultimately confirmed. These findings support the routine integration of POCUS into the diagnostic workup of dyspnoeic patients in Indian EDs.

POCUS cannot replace comprehensive clinical evaluation, chest radiography, or CT scanning — particularly for bilateral pulmonary infections, asthma exacerbations, and rare parenchymal disorders. Future multicentre, prospective studies with larger samples and operator blinding are needed to define condition-specific accuracy metrics and to establish standardised POCUS training curricula for emergency physicians in India.

DECLARATIONS

Ethics Approval: Institutional Ethics Committee approval was obtained prior to study commencement. Written informed consent was obtained from all participants.

Conflict of Interest: The authors declare no conflict of interest.

Funding: No external funding was received for this study.

Data Availability: Anonymised data are available from the corresponding author upon reasonable request.

Author Contributions: DSG: study conception, data collection, POCUS examinations, analysis, manuscript drafting. PK: study supervision, manuscript revision. AT: co-supervision, manuscript review.

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