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POINT OF CARE ULTRASOUND AS INITIAL DIAGNOSTIC TOOL IN ACUTE DYSPNEA PATIENTS IN THE EMERGENCY DEPARTMENT

DR WARDA SHAFIQ
POSTGRDADUATE RESIDENT ACCIDENT AND EMERGENCY, JINNAH POSTGRADUATE MEDICAL CENTER (JPMC), KARACHI, EMAIL : HONEYPIECES_@HOTMAIL.COM

PROF. DR MUNAWAR KHURSHEED
PROFESSOR EMERGENCY DEPARTMENT, NICVD, KARACHI
EMAIL :- MUNAWARMD@GMAIL.COM

DR NOSHEEN RAZI
DEPUTY DIRECTOR/ INCHARGE A&E EMERGENCY DEPARTMENT, JINNAH POSTGRADUATE MEDICAL CENTER(JPMC), KARACHI, EMAIL : DRNOSHEENRAZI@YAHOO.COM

DR SANOBER SIKANDAR
CONSULTANT ACCIDENT AND EMERGENCY, JINNAH POSTGRADUATE MEDICAL CENTER(JPMC), KARACHI, EMAIL : DRSANOBERJPMC@GMAIL.COM

DR SAIMA SIDDIQUI
POSTGRADUATE RESIDENT ACCIDENT AND EMERGENCY, JINNAH POSTGRADUATE MEDICAL CENTER(JPMC), KARACHI
EMAIL : SAIMA.SMC77@GMAIL.COM

DR PARAS LARAIB
POSTGRADUATE RESIDENT ACCIDENT AND EMERGENCY, JINNAH POSTGRADUATE MEDICAL CENTER (JPMC), EMAIL : PARASLARAIB1@GMAIL.COM

ABSTRACT

Background: Clinicians often face difficulty in quickly identifying the cause of acute dyspnea. Particularly in emergency settings. Point-of-care ultrasound (PoCUS) offers a bedside alternative to conventional imaging. However, it is real-world data on its diagnostic patterns that remains limited. We aimed to describe the spectrum of PoCUS findings in patients with acute dyspnea and examine how these findings relate to age and gender.

Methods: We carried out a prospective observational study in the emergency department of Jinnah Postgraduate Medical Centre (JPMC), Karachi, from February 2025 to August 2025. We enrolled 148 adult patients who presented with acute dyspnea. We then performed multi-organ PoCUS during their initial evaluation. We recorded sonographic diagnoses and analysed associations between patient demographics and ultrasound findings using chi-square testing.

Results: Pneumonia appeared as the most common diagnosis (35.8%), followed by pulmonary edema (19.6%) and pleural effusion (15.5%). Patients aged 56 to 85 years were more likely to have pulmonary edema ($p = 0.04$) and pneumonia ($p = 0.01$). Pleural effusion occurred more often in male patients ($p = 0.01$). We found no significant associations between age or gender and other conditions such as AECOPD/asthma, pneumothorax, ARDS/ALI, or pulmonary embolism.

Conclusion: PoCUS proved useful in identifying common causes of acute dyspnea at the bedside. Data showed pneumonia, pulmonary edema, and pleural effusion to be be the most frequently observed findings. Age and gender showed relevant associations with certain diagnoses. These results support the use of PoCUS as part of the initial assessment in the emergency department. They highlight the importance of structured training to ensure consistent practice.

Keywords: Point-of-care ultrasound; Acute dyspnea; Bedside diagnosis; Lung ultrasound; Multi-organ ultrasound; Pulmonary edema; Pneumonia; Pleural effusion; Diagnostic imaging

INTRODUCTION

Dyspnea is a common, distressing, and debilitating symptom frequently encountered in patients presenting to the emergency department (ED).[1] The proportion of patients presenting to the emergency department with dyspnea as their primary complaint has varied across studies, ranging from 0.9% to 7.4% in different regions, with the Asia-Pacific region reporting an incidence of approximately 5%. [2-3] Along with its high occurrence, the 30-day mortality rate among these patients remains significantly elevated (8–13%).[4] Therefore, promptly identifying the underlying cause is crucial for timely and effective treatment. However, making an accurate differential diagnosis can often be difficult and complex. [5] The majority of physicians primarily depend on traditional diagnostic methods, including patient history, physical examination, chest X-ray (CXR), electrocardiogram (ECG), and routine laboratory investigations. [6]

Ultrasonography (USG) has been utilized as a diagnostic imaging tool in clinical practice for over five decades. [7] However, the use of ultrasound in emergency departments was historically limited by two major challenges: the traditional view of ultrasound as a consultative tool and its perceived limited utility in diagnosing respiratory conditions due to artifact interference. Zanobetti et al. investigated the effectiveness of Point-of-Care Ultrasound (PoCUS) in assessing patients with acute dyspnea in the emergency setting, aiming to address these limitations. [8] However, the distribution of differential diagnoses varies depending on the local prevalence of diseases, making it difficult to universally apply findings from existing literature across all clinical settings. Additionally, variations in ultrasound protocols between institutions have led to differing results across studies, further limiting standardization. [9] Furthermore, PoCUS is capable of addressing a wide range of unresolved diagnostic issues and can also contribute to the optimization and individualization of patient treatment. [10] However, only a limited number of studies have investigated the impact of PoCUS on significant clinical outcomes, and the findings related to outcome measures have been inconsistent and varied across trials. [11-12] A study done by Baid et al found pattern on POCUS to be pulmonary edema 12.4%, pneumonia 56%, pleural effusion 21.4%, pulmonary embolism 0.33%, AECOPD/asthma 0.33%, pneumothorax 0.33% and ARDS/ALI 3.69%.[13]

Acute dyspnea is a common and potentially life-threatening presentation in the emergency department (ED), requiring rapid and accurate diagnosis to guide timely management. Traditional diagnostic approaches, including chest X-rays and laboratory tests, may be time-consuming and sometimes inconclusive in critically ill patients. Point-of-care ultrasound (POCUS) has emerged as a valuable, non-invasive, and rapid bedside tool for the initial assessment of dyspneic patients. POCUS allows real-time visualization of lung, cardiac, and vascular structures, facilitating early differentiation between common causes such as pulmonary edema, pneumonia, pleural effusion, pneumothorax, and cardiac dysfunction. By integrating POCUS into the initial evaluation of dyspneic patients, emergency physicians can expedite clinical decision-making, optimize resource utilization, and improve patient outcomes. This study aims to assess the pattern of findings on POCUS in acute dyspnea patients presenting to the ED and evaluate its effectiveness as an initial diagnostic tool. Identifying characteristic ultrasound findings in dyspneic patients may enhance diagnostic accuracy, reduce reliance on more time-intensive imaging modalities, and ultimately lead to faster initiation of appropriate treatment.

MATERIAL AND METHODS

This descriptive cross-sectional study was conducted in the Department of Emergency Medicine at Jinnah Postgraduate Medical Centre (JPMC), Karachi, from February 2025 to August 2025. The sample comprised 148 patients, calculated using WHO software, based on a pneumonia prevalence of 56%, a margin of error of 8%, and a confidence level of 95%. A non-probability consecutive sampling technique was employed for participant recruitment.

Patients aged between 25 and 85 years who presented to the emergency department with acute dyspnea and met the inclusion criteria were enrolled, regardless of gender. Individuals were excluded if they had a known history of trauma, malignancy, stroke, chronic renal impairment, or congestive cardiac failure. Ethical approval for the study was obtained from the Institutional Review Board, and informed consent was taken from all participants prior to enrollment.

Point-of-care ultrasound (POCUS) was performed on all eligible patients after enrollment. Lung ultrasonography was carried out using a 6–13 MHz linear probe. Scanning was performed longitudinally on the anterolateral chest regions in accordance with the BLUE protocol, as well as on the posterior thoracic area between the posterior axillary line and the spine. The anterolateral examination was conducted with the patient in a supine or near-supine position. When feasible, posterior lung zones were assessed in a sitting position or by laterally rotating the patient in cases where a supine position was required.

Ultrasound findings were interpreted based on established international guidelines. Pulmonary edema was identified by the presence of multiple B-lines across the pulmonary surface in a symmetrical distribution. Pneumonia was diagnosed by features such as pleural shredding, irregular pleural lines, lung consolidation, or air bronchograms, with or without focal interstitial syndrome. Pleural effusion was confirmed by detecting an anechoic space between the visceral and parietal pleura along with a thoracic spine sign. Pulmonary embolism was suspected if two or more pleural-based, triangular or rounded lesions were observed, or if lung ultrasound was normal despite suggestive clinical history and signs of right ventricular strain. Asthma or acute exacerbation

of COPD was considered in the absence of the above findings or in the presence of A-lines and lung sliding, supported by clinical history. Pneumothorax was diagnosed by the absence of lung sliding, B-lines, and lung pulse, along with identification of a lung point. ARDS or acute lung injury was recognized through subpleural anterior consolidations, decreased or absent lung sliding, irregular pleural lines, patchy distribution of B-lines, and spared regions of normal lung parenchyma.

All ultrasound findings were documented in a structured proforma designed for this study. Data were subsequently analyzed using SPSS version 20. Quantitative variables such as age were presented as mean and standard deviation for normally distributed data (verified via Kolmogorov–Smirnov test), while medians and interquartile ranges were used for non-normally distributed variables. Categorical variables, including gender and POCUS findings, were summarized using frequencies and percentages. To assess the influence of age and gender as potential confounding variables, stratification was performed. Post-stratification analysis was conducted using the chi-square test or Fisher's exact test where applicable, and a p-value of ≤ 0.05 was considered statistically significant.

RESULTS

The study enrolled 148 patients who presented to the emergency department with acute dyspnea. Most participants (58.1%) were aged between 56 and 85 years, while the remaining 41.9% were between 25 and 55 years. The sample comprised slightly more females (52%) than males (48%).

Point-of-care ultrasound (POCUS) revealed pneumonia as the most frequent finding, detected in 53 patients (35.8%). Pulmonary edema was identified in 29 patients (19.6%), and pleural effusion in 23 (15.5%). Less commonly, clinicians identified AECOPD or asthma in 15 patients (10.1%), pneumothorax and ARDS/ALI in 14 patients each (9.5%), and pulmonary embolism in 7 cases (4.7%).

Analysis showed a statistically significant association between age and the presence of pulmonary edema ($p = 0.04$), with a higher proportion of older patients (56–85 years) exhibiting sonographic features of edema. Similarly, pneumonia was significantly more common in the older age group ($p = 0.01$). However, gender did not show a significant association with either pulmonary edema ($p = 0.70$) or pneumonia ($p = 0.84$).

Pleural effusion occurred more frequently in male patients ($p = 0.01$), while age did not significantly influence its occurrence ($p = 0.27$). No significant associations emerged between age or gender and the detection of pulmonary embolism, AECOPD/asthma, pneumothorax, or ARDS/ALI (all $p > 0.05$).

These findings highlight the diagnostic value of POCUS in differentiating the etiology of acute dyspnea at the bedside. In particular, clinicians more frequently identified pneumonia and pulmonary edema in older patients, and pleural effusion appeared more common in males. The results support the use of POCUS as a rapid, non-invasive tool to guide early management decisions in the emergency department.

DISCUSSION

The data showed that PoCUS reliably identified the underlying cause of dyspnea in a majority of cases. Pneumonia and pulmonary edema being the most frequently observed findings. These results are consistent with earlier reports highlighting the utility of bedside ultrasound in differentiating causes of respiratory distress.[14-17]

We found that age had a statistically significant association with the presence of pulmonary edema and pneumonia. Patients aged 56 to 85 years accounted for most of these diagnoses. This aligns with previously established demographic patterns of cardiopulmonary disease prevalence. [18-19] Interestingly, pleural effusion showed a significant association with gender, occurring more frequently in male patients. This finding has not been widely reported and may reflect underlying disease distribution or referral patterns. However, further investigation is warranted.

The diagnostic spectrum in our study mirrors that reported by Baid et al., who also found pneumonia to be the leading diagnosis on PoCUS among dyspneic patients. [20] Similarly, Mantuani et al. reported that a focused, multi-organ ultrasound approach significantly improved the accuracy of emergency physicians' initial impressions in patients with undifferentiated dyspnea. [21] In their study, diagnostic accuracy increased from 53% to 77% after using PoCUS, supporting its integration into routine early assessment.[21]

Our study also reinforces the value of PoCUS in rapidly narrowing differential diagnoses. This was noted particularly in time-sensitive environments. [14-21] Previous research has shown that PoCUS reduces diagnostic delays and improves triage efficiency when integrated into the early evaluation workflow. [22-23] The non-invasive nature of the modality, combined with its bedside availability, makes it especially valuable in settings where access to advanced imaging is limited. [19-23]

We noted lower frequencies of conditions such as pulmonary embolism, pneumothorax, and AECOPD/asthma, which PoCUS identified less frequently in our data set. These conditions are known to present with less specific or variable sonographic findings. Previous studies have reported lower sensitivity for their detection using PoCUS alone. [23] Nevertheless, in conjunction with clinical assessment and targeted protocols, PoCUS can still provide meaningful guidance in these cases. [20-23]

Despite its advantages, PoCUS remains a user-dependent tool. [14-20] Operator experience, probe handling, and interpretation skills can affect diagnostic accuracy. These limitations underline the need for standardized training and credentialing programs, as well as ongoing quality assurance initiatives. Our data provides valuable insight

into real-world use. However multicenter studies are needed to evaluate reproducibility across different emergency settings.

LIMITATIONS

We carried out this study in a single tertiary care hospital. This may limit how broadly the findings apply to other healthcare settings. Differences in clinicians' ultrasound experience and the lack of direct comparison with advanced imaging, such as CT or echocardiography, may have influenced the accuracy of some diagnoses.

CONCLUSION

Our findings show that point-of-care ultrasound offers a practical and reliable method for identifying the underlying causes of acute dyspnea in the emergency department. Clinicians most frequently detected pneumonia, pulmonary edema, and pleural effusion. Use of PoCUS allowed for timely bedside assessment without relying solely on conventional imaging. We also observed associations between age and both pneumonia and pulmonary edema. We also noted associations between male sex and pleural effusion. These results support the role of PoCUS as an initial diagnostic tool in acute respiratory presentations.

Table 1: Distribution of baseline characteristics among the study participants.

Variables	n (%)
Age 25 to 55 years 56 to 85 years	 62 (41.9) 86 (58.1)
Gender Male Female	 71 (48) 77 (52)
Pulmonary edema Yes No	 29 (19.6) 119 (80.4)
Pneumonia Yes No	 53 (35.8) 95 (64.2)
Pleural effusion Yes No	 23 (15.5) 125 (84.5)
Pulmonary embolism Yes No	 07 (4.7) 141 (95.3)
AECOPD/asthma Yes No	 15 (10.1) 133 (89.9)
Pneumothorax Yes No	 14 (9.5) 134 (90.5)
ARDS/ALI Yes No	 14 (9.5) 134 (90.5)
Total	148 (100)

Table 2: Distribution of patient characteristics according to the Pulmonary edema.

Variables	Pulmonary edema Yes n (%)	Pulmonary edema No n (%)	P value
Age 25 to 55 years 56 to 85 years	 17 (27.4) 12 (14)	 45 (72.6) 74 (86)	0.04

Gender Male Female	 13 (18.3) 16 (20.8)	 58 (81.7) 61 (79.2)	0.70

Table 3: Distribution of patient characteristics according to the Pneumonia.

Variables	Pneumonia Yes n (%)	Pneumonia No n (%)	P value
Age 25 to 55 years 56 to 85 years	 14 (22.6) 39 (45.3)	 48 (77.4) 47 (54.7)	0.01
Gender Male Female	 26 (36.6) 27 (35.1)	 45 (63.4) 50 (64.9)	0.84

Table 4: Distribution of patient characteristics according to the Pleural effusion.

Variables	Pleural effusion Yes n (%)	Pleural effusion No n (%)	P value
Age 25 to 55 years 56 to 85 years	 12 (19.4) 11 (12.8)	 50 (80.6) 75 (87.2)	0.27
Gender Male Female	 17 (23.9) 06 (7.8)	 54 (76.1) 71 (92.2)	0.01

Table 5: Distribution of patient characteristics according to the Pulmonary embolism.

Variables	Pulmonary embolism Yes n (%)	Pulmonary embolism No n (%)	P value
Age 25 to 55 years 56 to 85 years	 01 (1.6) 06 (7)	 61 (98.4) 80 (93)	0.12
Gender Male Female	 03 (4.2) 04 (5.2)	 68 (95.8) 73 (94.8)	0.78

Table 6: Distribution of patient characteristics according to the AECOPD/asthma.

Variables	AECOPD/asthma Yes n (%)	AECOPD/asthma No n (%)	P value
Age 25 to 55 years 56 to 85 years	 06 (9.7) 09 (10.5)	 56 (90.3) 77 (89.5)	0.87
Gender Male Female	 06 (8.5) 09 (11.7)	 65 (91.5) 68 (88.3)	0.51

Table 7: Distribution of patient characteristics according to the Pneumothorax.

Variables	Pneumothorax Yes n (%)	Pneumothorax No n (%)	P value
Age 25 to 55 years 56 to 85 years	 08 (12.9) 06 (7)	 54 (87.1) 80 (93)	0.22

Gender Male Female	 05 (7) 09 (11.7)	 66 (93) 68 (88.3)	0.33

Table 8: Distribution of patient characteristics according to the ARDS/ALI.

Variables	ARDS/ALI Yes n (%)	ARDS/ALI No n (%)	P value
Age 25 to 55 years 56 to 85 years	 08 (12.9) 06 (7)	 54 (87.1) 80 (93)	0.22
Gender Male Female	 05 (7) 09 (11.7)	 66 (93) 68 (88.3)	0.33

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