Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/ytxrdn57

DIAGNOSTIC ACCURACY OF POINT OF CARE ULTRASOUND IN ADULT PATIENTS PRESENTING WITH ACUTE DYSPNEA TO EMERGENCY DEPARTMENT

Dr. Muhammad Shehzad Ali Siddiqi[1], Dr. Numan Khan[2], Dr. Aizaz Ullah[3*], Dr. Faisal Muhammad[4], Dr. Muhammad Bilal[5], Dr. Emad Khan[6]

[1,2]Department of Emergency Medicine, CMH, Rawalpindi, Pakistan
[3*,4,5,6]Department of Emergency Medicine Lady Reading Hospital, Peshawar, Pakistan

***Corresponding Author:** Dr. Aizaz Ullah
*****Email: aixaxk77@gmail.com

ABSTRACT

Background

Lung ultrasonography as a diagnostic tool in various specialized and clinical contexts are all becoming more and more supported by data. Emergency physicians are actively researching and implementing focused multidimensional ultrasound as a mode of care technique because of the urgent requirement for diagnosis in the ED. However, research from local settings are scarce.

Objective

To ascertain the diagnostic accuracy of POCUS in identifying the different causes of sudden onset dyspnea taking final clinical diagnosis as gold standard.

Materials and Methods

A total of 219 male and female patients aging 20 to 60 years presenting with acute shortness of breath were enrolled at the department of emergency medicine, CMH Rawalpindi during the period 15th April 2022 till 14th April 2024. A point of care ultrasound was performed and findings were compared with final clinical diagnosis by emergency specialist. 2x2 table was used to draw the diagnostic accuracy.

Results

Mean age of the participants was 35.44±10.887 years with majority of the patient in the age group less than 40 years (n = 161, 73.5%) while male participants were 138 (63.0%), MRC grade 5 dyspnea was more common (n = 127, 58.0%). The sensitivity of POCUS for pneumonia was 23.5% and specificity was 76.7%. The kappa value for agreement was 0.027. The sensitivity of POCUS for pulmonary edema was 10.2%, specificity was 89.4% and kappa value was 0.004.

Conclusion

PoCUS exhibits considerable screening potential for various clinical conditions presenting with acute shortness of breath. It enables swift interpretations by integrating its comprehensive reliability, agreement with the ultimate composite diagnosis.

Key words: Acute Dyspnea, Point of Care Ultrasound, Diagnostic Accuracy.

INTRODUCTION

One of the common, upsetting, and incapacitating symptoms that patients bring to the ED (emergency room) is dyspnea.[1] According to many research, the percentage of patients who arrive at the emergency department (ED) with dyspnea as their primary symptom varies by geography, with a rate of 5% in asian population.[2,3]

Dyspnea is described as "a personal perception of difficulty breathing comprised of distinct qualitative feelings that fluctuate in severity".[4] When dyspnea is the primary symptom, wide range of diseases may manifest. Therefore, a prompt diagnosis is necessary to expedite the proper therapy and discharge of these patients from the emergency department.[5] Accurately identifying these individuals is made more challenging by the individuality of the manifestation, concurrent medical conditions, and other related clinical diseases that may cause dyspnea. Preliminary incorrect diagnosis are linked to greater fatalities and may result in longer hospital stays.[6] The appropriate diagnosis can frequently be determined with a careful history and physical assessment, although further diagnostic testing may be necessary in 30–50% of patients.[7]

A radiograph of the chest is frequently employed to assess an individual who is having trouble breathing, and further scans are occasionally necessary. These methods tend to be impractical for under special circumstances such as pregnant patients where exposure to radiation is contraindicated.[8] They rely on the institutions' resources (particularly CCT) and are of limited utility in severely sick patients. In order to identify and start focused treatment, the emergency department urgently needs an early diagnostic tool.[9]

For nearly decades, ultrasound (USG) has been extensively used in healthcare facilities as a screening technique. The prior idea of ultrasonography and the ultrasound's inadequate capacity to diagnose respiratory diseases because of artifacts, however, were two major obstacles that restricted its usage in the emergency room.[10] Lung ultrasonography has lately become a well-established diagnostic tool for seriously sick individuals in a variety of settings, including acute respiratory failure, nonspecific low blood pressure, and directing treatment such as fluid administration.[11]

Lung ultrasonography as a diagnostic tool in various specialized and clinical contexts are all becoming more and more supported by data. Emergency physicians are actively researching and implementing focused multidimensional ultrasound as a mode of care technique because of the urgent requirement for diagnosis in the ED. The objective of our observational study was to ascertain the diagnostic accuracy of PoCUS in identifying the different causes of sudden onset dyspnea and to compute the time advantage observed in the diagnosis and response decision compared to the conventional methods of achieving in a tertiary care hospital.

MATERIALS AND METHODS

This cross sectional validation study was carried out at the emergency department of Combined Military Hospital, Rawalpindi, during the period 15th April 2022 till 14th April 2024. A total of 219 male and female patients, aging 20 to 60 years, presenting with sudden onset shortness of breath were enrolled. Patients with history of chest trauma, patients with foreign body inhalation, malignant disease of the lung or pleura and severe ascites were excluded. Participants were registered though non-probability convenient sampling technique. Dyspnea was defined by MRC dyspnea rating scale. Patients with MRC grade 3 or above was called dyspnea. Ultrasound findings of interest that were recorded included: 1) Pulmonary edema: defined by presence of multiple lines of increased echogenicity across the parenchyma of the lung. 2) Pneumonia: liver like echogenicity of lung parenchyma 3) Pleural effusion: anechoic (dark area) above the diaphragm 4) Pneumothorax: absence of normal lung interface 5) Pulmonary embolism: wedge-shaped hypoechoic lesion in the parenchyma of the lung 6) Acute respiratory distress syndrome: Thickened pleural line with sub-pleural consolidations and inhomogeneous distribution of B-lines.

Participants were registered from emergency room of the hospital. Demographic and baseline information was gathered and vitals were noted. Clinical information like onset, duration, severity and associated symptoms with dyspnea were noted followed by relevant past history. Clinical

examination included vitals recording and palpation, percussion and auscultation of the back of the chest.

A gray scale 7-12MHz linear probe was used to perform the chest ultrasounds. All scans were carried out by the researcher. All scans were performed on the back of the chest while the patient was lying in left lateral position or sitting up with arms crossed around the chest. Gel was applied to the area of examination and probe was moved across the lung field on both right and left sides. Patient was asked to cough, sniff, deep breath in and out to get optimal images. Ultrasound findings were noted and compared with final established diagnosis after extensive workup and clinical examination.

Data was recorded on excel sheet and transferred to SPSS for analysis using IBM SPSS version 24. Continuous data was presented as means and standard deviations and categorical data as frequencies and percentages. Diagnostic accuracy of POCUS was measured using 2x2 tables taking final diagnosis as gold standard. Kappa analysis was performed to assess the similarity between POCUS findings and final established diagnosis.

RESULTS

As illustrated in table 1, the mean age of the participants was 35.44±10.887 years, mean BMI was 23.997±2.63 kg/m^2 and mean respiratory rate was 23.047±2.045 per minute.

Table 1. Means and standard deviations of patients according to various baseline parameters (n = 219)

Parameters	Mean	Std. Deviation
Age (years)	35.44	10.887
BMI (kg/m^2)	23.997	2.6398
Duration (days)	3.22	1.673
Pulse (per minute)	96.395	10.480
SBP (mmHg)	131.571	7.908
O2 sat (%)	91.447	3.590
Temp (^{0}C)	37.945	1.856
Resp rate (per minute)	23.047	2.405

Majority of the patient were aging less than 40 years (n = 161, 73.5%) while male participants were 138 (63.0%), MRC grade 5 dyspnea was more common (n = 127, 58.0%) and hypertension was most frequent comorbid condition (n = 55, 25.1%) as summarized in table 2.

Table 2. Frequencies and percentages according to clinic-demographic parameters (n = 219)

Parameters	Subgroups	Frequency	Percent
Age (years)	40 or below	161	73.5
	More than 40	58	26.5
Gender	Male	138	63.0
	Female	81	37.0
BMI (kg/m^2)	24.0 or below	127	58.0
	More than 24.0	92	42.0
Severity of dyspnea	MRC grade ¾	92	42.0
	MRC grade 5	127	58.0
Comorbidities	Hypertension	55	25.1
	Diabetes	37	16.9
	CLD	4	1.8
	CKD	25	11.4
	Malignancy	13	5.9
	TB	21	9.6
	None	64	29.2
	Total	219	100.0

POCUS findings and final diagnoses are reported in table 3. Most common POCUS findings were consistent with pneumonia (n = 51, 23.3%) as opposed to pulmonary edema in final diagnosis (n = 68, 31.1%).

Table 3. POCUS findings and final diagnosis (n = 219)

Modality	Diagnosis	Frequency	Percent
POCUS	Normal	86	39.3
	Edema	23	10.5
	Pneumonia	51	23.3
	Effusion	10	4.6
	Pneumothorax	21	9.6
	Embolism	13	5.9
	ARDS	15	6.8
Final diagnosis	Pneumonia	51	23.3
	Edema	68	31.1
	Effusion	26	11.9
	ARDS	11	5.0
	Embolism	7	3.2
	Pneumothorax	16	7.3
	Normal	40	18.3

Diagnostic accuracy of POCUS for various findings is presented in table 4. The sensitivity of POCUS for pneumonia was 23.5% and specificity was 76.7%. The kappa value for agreement was 0.027. The sensitivity of POCUS for pulmonary edema was 10.2%, specificity was 89.4% and kappa value was 0.004.

Table 4. Diagnostic accuracy of POCUS for various chest findings (n = 219)

Findings			Final Diagnosis		Total	Diagnostic accuracy	Kappa value
			Yes	No			
Normal	POCUS	Yes	17	69	86	Sen:42.5% Spe:61.4% PPV:19.7% NPV:82.7%	0.027
			19.8%	80.2%	100.0%		
		No	23	110	133		
			17.3%	82.7%	100.0%		
Pneumonia	POCUS	Yes	12	39	51	Sen:23.5% Spe:76.7% PPV:23.5% NPV:76.7%	0.003
			23.5%	76.5%	100.0%		
		No	39	129	168		
			23.2%	76.8%	100.0%		
Pulmonary Edema	POCUS	Yes	7	16	23	Sen:10.2% Spe:89.4% PPV:30.4% NPV:68.8%	0.004
			30.4%	69.6%	100.0%		
		No	61	135	196		
			31.1%	68.9%	100.0%		
Embolism	POCUS	Yes	7	212	219	Sen:50.0% Spe:50.0% PPV:3.1% NPV:96.8%	0.000
			3.2%	96.8%	100.0%		
		No	7	212	219		
			3.2%	96.8%	100.0%		
Pneumothorax	POCUS	Yes	2	19	21	Sen:12.5% Spe:90.6% PPV:9.5% NPV:9.2%	0.027
			9.5%	90.5%	100.0%		
		No	14	184	198		
			7.1%	92.9%	100.0%		
ARDS	POCUS	Yes	1	14	15	Sen:9.0% Spe:93.2% PPV:6.7% NPV:95.0%	0.020
			6.7%	93.3%	100.0%		
		No	10	194	204		
			4.9%	95.1%	100.0%		
Effusion	POCUS	Yes	1	9	10	Sen:3.7% Spe:95.3% PPV:10.0% NPV:87.5%	0.071
			10.0%	90.0%	100.0%		
		No	26	183	209		
			12.4%	87.6%	100.0%		

DISCUSSION

The mean age of the participants in our study was 35.44±10.887 years with majority of the patients in the age group less than 40 years (n = 161, 73.5%). The mean age and age-wise distribution on studies carried out on similar topics on western population is higher than our observation (mean age 50.0±15.8 years).[12,13] This may the results of overall higher life expectancy in western population as compared much lower rate in our country.

The male population constituted major portion of study population (n = 138, 63.0%). Gender-wise distribution was similar to our findings in a study by Guttikonda and colleagues.[14] The later study was carried out on Indian population sharing share similar features to our population.

Pneumonia was reported in 51 (23.3%). The sensitivity of POCUS for pneumonia was 23.5% and specificity was 76.7%. The kappa value for agreement was 0.027. Pneumonia was a frequent diagnosis in a study by Baid and colleagues (n = 188, 79.32%).[15] Though the proportion was much higher in the later study, the overall pattern of diagnoses in terms of frequency was similar to our observation. However, the sensitivity (85.6%) and specificity (88.0%) of ultrasound was better compared to our findings. Zanobetti and colleagues reported 85.6% sensitivity and 87.7% specificity of POCUS for pneumonia.[12] However, the negative predictive value of POCUS for ruling out pneumonia was similar to our study (76.7% versus 61.4%).[15]

Pulmonary edema was observed in 68 patients (31.1%). Pulmonary edema was observed in 35 (14.7%) in a study.[16] The sensitivity and specificity of POCUS for the diagnosis of pulmonary edema was 10.2% and 89.4% respectively. The kappa value for agreement between POCUS findings and final diagnosis was 0.004. Wang Y and colleagues reported sensitivity and specificity of 88.5% and 97.0% respectively for pulmonary edema in their study.[17] These findings were much higher than our observation. The lower diagnostic accuracy in our study may be due difference in parameters set for diagnosis in both studies. It may also have resulted from expertise of the operator and the quality of the instrument.

Pleural effusion was found in 26 (11.9%) participants as cause of acute dyspnea in our patients. the sensitivity and specificity of POCUS for effusion was 3.7% and 95.7% respectively. Hansell et al reported 100.0% sensitivity for the diagnosis of pleural effusion in their study and 92.0% specificity.[18] The contrast in sensitivity towards effusion may be due to amount of collection set as cut of in both studies.

The sensitivity of POCUS for ARDS in a study by Baid and colleagues was 28.5% as compared to 9.0% in our study.[15] Depending on the variations in lung ultrasonography methods, the regions assessed for the predetermined results, the criteria for ARDS, and the gold standard for comparison, could have attributed to contrasting results.

This study is not without limitations. Apart of limited sample size and restriction to single center, notwithstanding the existence of diagnostic standards, PoCUS is a subjective assessment method that might differ depending on the observer. Inter-observer heterogeneity assessment could enhance reliability of PoCUS usage. The final combined diagnosis established by emergency medicine specialists was the gold standard. It was impossible to rule out a clinical bias because they were also actively managing the patent. Despite our study's statistically significant results, the benefit in time comparison may change in other contexts based on logistics and available resources.

CONCLUSION

In order to enhance and expedite precise decision-making, the current study employed PoCUS as a primary diagnostic instrument for assessing acute breathing disorders individuals in the emergency room. PoCUS exhibits considerable potential screening tool, enabling swift interpretations by integrating its comprehensive reliability, agreement with the ultimate composite diagnosis.

REFERENCES

1. Parshall MB, Schwartzstein RM, Adams L, Banzett RB, Manning HL, Bourbeau J, et al. An Official American Thoracic Society Statement: update on the mechanisms, assessment, and management of dyspnea. Am J Respir Crit Care Med. 2012;185(4):435–452.
2. Kelly AM, Keijzers G, Klim S, Graham CA, Craig S, Kuan WS, et al. An Observational study of dyspnea in emergency departments: the Asia, Australia, and New Zealand Dyspnea in Emergency Departments Study (AANZDEM) Acad Emerg Med. 2017;24(3):328–336.
3. Mockel M, Searle J, Muller R, Slagman A, Storchmann H, Oestereich P, et al. Chief complaints in medical emergencies. Eur J Emerg Med. 2013;20(2):103–108.
4. Niska R, Bhuiya F, Xu J. National Hospital Ambulatory Medical Care Survey: 2007 emergency department summary. Natl Health Stat Report. 2010;26:1–31.
5. Ray P, Birolleau S, Lefort Y, Becquemin MH, Beigelman C, Isnard R, et al. Acute respiratory failure in the elderly: Etiology, emergency diagnosis and prognosis. Crit Care. 2006;10(3):1–12.
6. Berliner D, Schneider N, Welte T, Bauersachs J. The differential diagnosis of dyspnoea. Dtsch Arztebl Int. 2016;113(49):834–845.
7. Goldberg BB, Gramiak R, Freimanis AK. Early history of diagnostic ultrasound: the role of American radiologists. AJR Am J Roentgenol. 1993;160(1):189–194.
8. Lichtenstein DA, Mezière GA. Relevance of lung ultrasound in the diagnosis of acute respiratory failure: the BLUE protocol. Chest. 2008;134(1):117–125.
9. Perera P, Mailhot T, Riley D, Mandavia D. The RUSH Exam: Rapid Ultrasound in SHock in the Evaluation of the Critically lll. Emerg Med Clin North Am. 2010;28(1):29–56.
10. Lichtenstein D. FALLS-protocol: lung ultrasound in hemodynamic assessment of shock. Hear Lung Vessel. 2013;5(3):142–147.
11. Mandavia DP, Hoffner RJ, Mahaney K, Henderson SO. Bedside echocardiography by emergency physicians. Ann Emerg Med. 2001;38(4):377–382.
12. Zanobetti M, Scorpiniti M, Gigli C, Nazerian P, Vanni S, Innocenti F, et al. Point-of-Care Ultrasonography for evaluation of acute dyspnea in the ED. Chest. 2017;151(6):1295–1301.
13. Buhumaid RE, St-Cyr Bourque J, Shokoohi H, Ma IWY, Longacre M, Liteplo AS. Integrating point-of-care ultrasound in the ED evaluation of patients presenting with chest pain and shortness of breath. Am J Emerg Med. 2019;37(2):298–303.
14. Guttikonda SNR, Vadapalli K. Approach to undifferentiated dyspnea in emergency department: aids in rapid clinical decision-making. Int J Emerg Med. 2018;11(1):21.
15. Baid H, Vempalli N, Kumar S, Arora P, Walia R, Chauhan U, et al. Point of care ultrasound as initial diagnostic tool in acute dyspnea patients in the emergency department of a tertiary care center: diagnostic accuracy study. Int J Emerg Med. 2022 Jun 13;15(1):27.
16. Russell FM, Ehrman RR, Cosby K, Ansari A, Tseeng S, Christain E, et al. Diagnosing acute heart failure in patients with undifferentiated dyspnea: a lung and cardiac ultrasound (LuCUS) protocol. Acad Emerg Med. 2015;22(2):182–191.
17. Wang Y, Shen Z, Lu X, Zhen Y, Li H. Sensitivity and specificity of ultrasound for the diagnosis of acute pulmonary edema: a systematic review and meta-analysis. Med Ultrason. 2018;1(1):32–36.
18. Hansell L, Milross M, Delaney A, Tian DH, Ntoumenopoulos G. Lung ultrasound has greater accuracy than conventional respiratory assessment tools for the diagnosis of pleural effusion, lung consolidation and collapse: a systematic review. J Physiother. 2021;67(1):41–48.