COMPARISON OF POCUS WITH X-RAY CHEST IN PATIENTS WITH PLEURAL EFFUSION IN THE EMERGENCY DEPARTMENT

1. Dr. Muhammad Uzair
Postgraduate Trainee, Emergency Medicine
Ziauddin University, Karachi, Pakistan
2. Dr. Inayat Ali Khan
Consultant Neurosurgeon & HOD Emergency Medicine Department
Ziauddin University, Karachi, Pakistan
3. Dr. Sana Ilyas
Postgraduate Trainee, Emergency Medicine
Ziauddin University, Karachi, Pakistan
4. Dr. Khalid Khan
Postgraduate Trainee, Emergency Medicine
Ziauddin University, Karachi, Pakistan
5. Dr. Ali Anwar
Postgraduate Trainee, Emergency Medicine
Ziauddin University, Karachi, Pakistan
6. Dr. Ummarah Imran
Postgraduate Trainee, Emergency Medicine
Ziauddin University, Karachi, Pakistan
7. Dr. Jabran Wasti
Communicating Author
Postgraduate Trainee, Emergency Medicine
ORCID: 0009-0000-9037-3473

Abstract:
Introduction: Ultrasonography and point of care ultrasound (POCUS) have become tool in assessing effusion particularly in dyspnea patients. This study aims to evaluate the accuracy of POCUS in detecting effusion. Presents the research objectives, definitions, research question, hypothesis, materials and methods as well as the results.
Methods: We conducted a sectional study at Ziauddin University Hospitals emergency department (North Campus) in Karachi. A total of 50 dyspnea patients were included in the study and both POCUS and chest X rays (CXR) were performed to assess effusion. The diagnostic accuracy of POCUS was determined using CXR as the gold standard.
Results: Among the 50 dyspnea patients examined POCUS detected effusion in 46 patients (92.0%) while CXR detected it in 38 patients (76.0%). The prevalence of effusion was determined to be 76.0%. The calculated diagnostic accuracy of POCUS was found to be 84% with a sensitivity of 100% specificity of 33.33% value of 82.61% and negative predictive value of 100%. These findings suggest that while POCUS exhibits sensitivity for diagnosing effusion its specificity is relatively low, as an initial diagnostic tool.
Conclusion: Point of Care Ultrasound (POCUS) proves to be an effective method, for identifying pleural effusion in patients experiencing shortness of breath. However it's important to note that its reliability as a tool may have some limitations due to its positive predictive value.
Keywords: POCUS, pleural effusion, chest x-ray, dyspnea, emergency department, bedside ultrasound.

INTRODUCTION

Dyspnea is a common symptom in emergency departments, with an incidence ranging from 0.9 to 7.4% in various regions. The prevalence of dyspnea varies greatly between countries, and several factors contribute to these differences. There are several dyspnea measures, but it is unclear which scale should be used and whether or not the conventional method is suitable. Over 15% of people suffer from dyspnea, which may be due to a high prevalence of cardiopulmonary disorders, lifestyle modifications, obesity and subclinical medical conditions (2).

Acute dyspnea can be caused by various medical conditions, including respiratory, cardiac, metabolic, traumatic and allergy-related conditions (3)(4). An accurate diagnosis is essential for proper therapy and discharge from the ED. However, initial misdiagnoses are linked to higher mortality and longer hospital stays.

Point of care ultrasound (POCUS) is a tool commonly used in emergency medicine to address worsening of patient conditions caused by dyspnea, hypotension and shock. By expediting procedures and improving both diagnosis and treatment POCUS offers benefits (5).

A study conducted at a tertiary care facility, in Karachi Pakistan aimed to assess the accuracy of POCUS in diagnosing effusion in patients experiencing acute dyspnea. The study also sought to determine if POCUS provides any time saving advantages compared to chest X rays when making diagnoses and deciding on disposition.

In Pakistan the incidence of dyspnea has increased due to illnesses. Early diagnosis plays a role in providing therapy and facilitating timely discharge from the emergency department (ED) (6). However accurate diagnosis can be challenging due to subjectivity overlapping causes and comorbidities (7). Initial misdiagnoses can result in hospital stays and higher mortality rates. Consequently, point of care ultrasound (POCUS) is gaining recognition as a tool worldwide. In fact many medical schools are contemplating incorporating POCUS courses into their curricula (8).

By enabling bedside visualization of effusions through the identification of plankton signs and hyperechoic debris POCUS help to identify the type of effusion and can avoid traditional methods that often rely on radiology reports and laboratory findings for treating dyspnea. These conventional approaches can be time consuming and less effective, for patients experiencing deteriorating dyspnea. POCUS has higher sensitivity and specificity for locating pleural effusions at bedside and can help in reassessment in deteriorating patients (9)(10). POCUS can start targeted therapy immediately and it can help to plan out long-term management and can also avoid additional medical workforce, equipment or charges for the patient and their family (9).

Methodology

The target population for this study consists of individuals who are experiencing dyspnea and seek medical attention in the emergency department. The study design employed in this research is a cross-sectional study. The duration of the study spans a period of six months, commencing on January 1, 2023, and concluding on June 30, 2023.

The sample size was determined using the Lin Naing calculator, with sensitivity set at 100%, specificity at 98%, prevalence at 0.32% (Medscape, 2021), and a confidence interval of 95%. The sample size of 46 was determined by utilizing numbers obtained from prior research investigations and using the Lin Naing calculator for calculation purposes. The ultimate number of samples obtained for analysis was 50. The study technique employed in this research is the purposive consecutive sampling strategy.

The criteria for inclusion in the sample were those who provided informed consent, aged 18 or older. Both genders were included and consist of individuals who present with a sudden onset of difficulty breathing. Exclusion criteria encompass patients who express a desire to voluntarily withdraw from participating in the trial without assigning any reason, pregnant women and patients who were involved in road traffic accidents

The data collection procedure involved obtaining study authorization from the Ethical Review Committee (ERC) and Clinical Research Committee (CRC) of the institute. The research was conducted at the emergency department located at the North Campus of Ziauddin University and Hospitals. All individuals who presented with successive episodes of dyspnea were included in the study. The patient (or their next

of kin) provided informed consent, and a comprehensive proforma was completed to document the patient's medical history and risk factors. The attending duty emergency physician or resident conducted a comprehensive physical examination to evaluate the presence of signs. The emergency physicians or residents documented the data and performed bedside chest ultrasonography. The identification of fluid accumulation in the basal lung areas was documented and subsequently compared using chest X-ray imaging.

The data analysis procedure involved the utilization of Statistical Package for Social Sciences (SPSS) version 21. The normality of quantitative data, including age, blood pressure, oxygen saturation, pulse and temperature, was evaluated using the Shapiro-Wilk test. The mean and standard deviation were employed to analyse data that followed a normal distribution, while the median (accompanied by the interquartile range, or IQR) was utilized for data that did not exhibit a normal distribution. Characteristics like past history of the patients and comorbidities was taken to determine the frequencies and percentages of pleural effusion. Data was analysed to compute the frequencies and percentages of effusion detected through point-of-care ultrasound (POCUS) and chest X-rays. Stratification was done to address effect modifiers that could influence the results such as gender, age, smoking status and patient medical history.

A 2x2 table was made to calculate the accuracy for point-of-care ultrasonography (POCUS) in diagnosing effusion. These measures included sensitivity, specificity, positive predictive value, negative predictive value and overall diagnostic accuracy. These were compared to calculations of data obtained from chest X-rays. A significance level of 0.05 was considered significant at a confidence level of 95%.

Results:

A total of fifty patients experiencing difficulty breathing were assessed for effusion using both CXR and POCUS. The average age was 65.4 years with an average systolic blood pressure of 123 ± 34.9 mmHg and an average diastolic blood pressure of 71 ± 21.8 mmHg. The saturation recorded on average was at 94.7% ± 7.5, while the pulse rate averaged at 94.6 ± 7.8 bpm. The mean temperature was measured at 99.9±1.1 °C.

Patients experiencing difficulty breathing exhibited clinical symptoms like coughing, hematemesis, chest pain that worsens with deep breaths, fever and swelling. All 50 patients (100.0%) had effusion with 46 patients (92.0%) displaying the presence of build up in the pleural cavity while it was absent in 4 patients (8.0%). The distribution of pleural effusion was also distributed by gender, age group and clinical signs and symptoms.

Pleural effusion was present in 38 (100.0%) acute dyspnea patients and absent in 12 (100.0%) patients. The sensitivity and specificity of POCUS were calculated using CXR as the gold standard with pleural effusion presence classified into true positive, false negative, false positive and true negative.

Diagnostic accuracy of POCUS was calculated using CXR as the gold standard with a disease prevalence of pleural effusion of 76.00%, sensitivity of 100.00%, specificity of 33.33%, PPPV of 82.61%, NPV of 100.00% and diagnostic accuracy of 84.00%.

Table 1: Distribution of Pleural Effusion in Acute Dyspnea Patients

Pleural Effusion		Frequency	Percentage
POCUS	Present	46	92.0%
	Absent	4	8.0%
	Total	50	100.0%
CXR	Present	38	76.0%
	Absent	12	24.0%
	Total	50	100.0%

Table 2: Distribution of Pleural Effusion on CXR in Acute Dyspnea Patients with Respect to POCUS

POCUS	Pleural Effusion on CXR		P-Value
	Present	Absent	
Present	38 (100.0%)	8 (66.7%)	< 0.001
Absent	0 (0.0%)	4 (33.3%)	
Total	38 (100.0%)	12 (100.0%)	

Table 3: Sensitivity and Specificity 2×2 Table for POCUS

POCUS	Chest X-Ray	
	Positive	Negative
Positive	38 (76.0%)	8 (16.0%)
Negative	0 (0.0%)	4 (8.0%)

Table 4: Distribution of Pleural Effusion on CXR in Acute Dyspnea Patients with Respect to Sign and Symptoms

Sign and Symptoms		Pleural Effusion on CXR		P-Value
		Present	Absent	
Acute Dyspnea	Yes	38 (100.0%)	12 (100.0%)	---
	No	0 (0.0%)	0 (0.0%)	
Cough	Yes	29 (76.3%)	7 (58.3%)	0.226
	No	9 (23.7%)	5 (41.7%)	
Hemoptysis	Yes	9 (23.7%)	3 (25.0%)	0.926
	No	29 (76.3%)	9 (75.0%)	
Pleuritic Chest Pain	Yes	20 (52.6%)	7 (58.3%)	0.730
	No	18 (47.4%)	5 (41.7%)	
Fever	Yes	27 (71.1%)	6 (50.0%)	0.180
	No	11 (28.9%)	6 (50.0%)	
Edema	Yes	8 (21.1%)	4 (33.3%)	0.385
	No	30 (78.9%)	8 (66.7%)	

Table 7: Diagnostic Accuracy for POCUS

Diagnostic Accuracy	Value	95% CI
Disease Prevalence	76.00%	61.83% to 86.94%
Sensitivity	100.00%	90.75% to 100.00%
Specificity	33.33%	9.92% to 65.11%
PPV	82.61%	68.58% to 92.18%
NPV	100.00%	39.76% to 100.00%
Diagnostic Accuracy	84.00%	70.89% to 92.83%

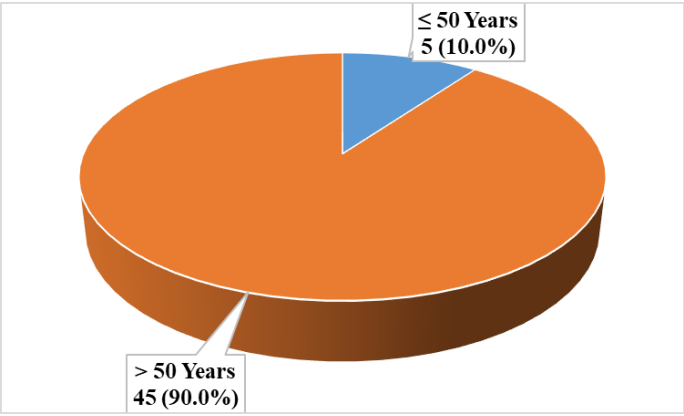

Figure 1: Patients according to age

Discussion:

Point-of-care ultrasound (POCUS) is a rapidly developing field in medicine that has become a crucial component of physical examinations (11). POCUS can quickly support diagnostic algorithms at the point of care, but users often struggle with handling incidental findings(12). Incidental discoveries which can range from 1.6% to 26% are unrelated to the patient's primary complaint and require more investigation (13)(14). The need for systematic, evidence-based guidelines to ensure necessary follow-up while preventing unnecessary extra imaging, patient worry and increased costs is raised (13). POCUS complements physical examinations with ultrasound at the patient's bedside, providing instant clinical information, helping doctors make diagnoses and supporting clinical decision-making (15). It can lead to quicker diagnosis times in dyspneic patients, shorter stays in intensive care units and quicker discharge times in heart failure patients (16). POCUS exams are simple to repeat when the patient's state changes, giving quick input for treatment plan evaluation.

POCUS has been shown to rule in and rule out life-threatening diseases with an accuracy comparable to chest X-rays (CXR) (17-19). However, the added usefulness of CXR becomes insignificant due to its higher sensitivity in normal lung ultrasonography (17). POCUS also has a considerable time benefit with results available immediately (20). POCUS has superior sensitivity and specificity for locating pleural effusion when compared to chest X-ray (21-24), as well as the ability to estimate the size of a pleural effusion using the Balik formula, unlike chest X-rays, which cannot detect pleural effusion if it is less than 200 ml. POCUS is also helpful in determining the type of effusion, whether transudative or exudative, based on the effusion seen on POCUS (25)(26).

The incidence of dyspnea in Pakistan has been on the rise in recent years, with a wide range of illnesses causing dyspnea as the main symptom. Early diagnosis is essential for proper therapy and discharge from the emergency department. Traditional methods often depend on radiologic and laboratory findings, which can take an excessive amount of time before appropriate medication is initiated. POCUS has higher sensitivity and specificity for locating pleural effusions at bedside compared to traditional radiography and can help in reassessment in deteriorating patients.

This study was conducted in the emergency department of Ziauddin University Hospital (North Campus) in Karachi to evaluate the diagnostic accuracy of POCUS in detecting pleural effusion in dyspnea patients using CXR as the gold standard. Out of 50 patients suffering from acute dyspnea, pleural effusion was diagnosed in 46 (92.0%) patients on POCUS and 38 (76.0%) patients on CXR. The disease prevalence of pleural effusion was 76.0% (95% CI: 61.83%–86.94%).

Using CXR as the gold standard, POCUS diagnostic accuracy was 84.00% (95% CI: 70.89%–92.83%), with sensitivity 100.0%, specificity 33.33%, positive predictive value 82.61%, and negative predictive value 100.00%. Different studies reported different sensitivity of POCUS in emergency departments, but the higher NPV of 100% establishes it as a reliable tool for diagnosing pleural effusion.

In this study the majority of patients [45 (90.0%)] that presented with acute dyspnea were in the age group of 50 years (Figure 1), it may be mentioned that of these 45 patients, 33 (86.8%) and 5 patients (100%) patients were confirmed to have pleural effusion on CXR (Table 6). Hence the risk of developing pleural effusion is higher in patients over 50 years of age.

All patients diagnosed with pleural effusion on CXR were reported to have the following symptoms: acute dyspnea in 38 (100.0%) patients, cough in 29 (76.3%) patients, fever in 27 (71.1%) patients, pleuritic chest pain in 20 (52.6%) patients, hemoptysis in 9 (23.7%) patients and edema in 8 (21.1%) patients (Table 4). Different studies have reported that dyspnea, pleuritic chest pain, fever and cough are directly associated with pleural effusion and patients presenting with these symptoms may be referred for CXR and POCUS evaluation.

Overall, the findings in this study are consistent with previous researches, such as the high accuracy of POCUS in detecting pleural effusion and the presence of different clinical signs and symptoms in patients suffering from pleural effusion. Implementation of this approach has the potential to result in expedited diagnostic processes for individuals experiencing dyspnea, reduced durations of hospitalization in intensive care units and accelerated discharge dates for patients with dyspnea. POCUS can be easily repeated in response to changes in the patient's condition, providing prompt feedback for the evaluation of treatment plans.

Conclusion:

For patients presenting with acute dyspnea, POCUS serves as a valuable adjunct to physical examinations by offering real-time clinical information at the patient's bedside. This tool aids physicians in making accurate diagnoses and facilitates informed clinical decision-making

Further Recommendations:

It is recommended that all hospitals incorporate this tool within their emergency department, accompanied by comprehensive training for their doctors. This approach would facilitate prompt patient management and will lead to a reduction in both patient costs and healthcare provider expenses.

Limitation:

This is a one-hospital conducted small-scale research. A few patients were evaluated. Only emergency department patients with acute dyspnea were tested for pleural effusion. Using chest radiography as the gold standard for pleural effusion diagnosis may have overlooked minor effusions, as it only detects those exceeding 200 mL. CT was not used to confirm pleural effusion. The study does not examine the cause or treatment of pleural effusion.

ETHICS APPROVAL

The study has been approved by the ERC committee of the Ziauddin University.

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CONFLICT OF INTEREST:
The authors declare no competing interests whatsoever.
PATIENT'S CONSENT:
All patients and/or their family members were counseled and a full informed and detailed written consent was obtained prior to inclusion of patients in this study.
AUTHORS' CONTRIBUTION:
The authors have been fully contributed in the critical write-up of this research study

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