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RESEARCH ARTICLE

POCUSTO DIFFERENTIATE DYSPNEAPRESENTING TO EMERGENCY DEPARTMENT

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Abstract

Background: Emergency department(ED) faces challenges in diagnosis and management of patients presenting with acute dyspnea due to resource limited settings. Hence the present study was conducted with the main aim of evaluating a diagnostic strategy using point of care ultrasonography (POCUS) to distinguish patients presenting with acute dyspnea to ED into different diagnostic categories for timely management.
Methods: This is a prospective cohort study conducted with total of 50 patients. To assess the diagnostic accuracy of using POCUS in evaluating patients presenting with dyspnea as a predominant complaint to ED. POCUS includes lung-cardiac-IVC, lung usg to identify(diffuse B lines, lung sliding sign, consolidation, pleural effusion etc.,), cardiac usg for left ventricular function, right atrial and right ventricular enlargement, pericardial effusion, cardiac tamponade, inferior vena cava(IVC) diameter and collapsibility. Later, out of nine POCUS diagnosis defined in the study algorithm patients were treated and compared with final hospital diagnosis to estimate the accuracy of this strategy.
Results: ED diagnosis of dyspnea using the diagnostic strategy proposed in the study was in compliance with final hospital diagnosis with high agreement in 86% of patients with Kappa statistic = 0.798 ($p<0.001$) which is statisticaly significant.Acute decompensated heart failure (ADHF) was the most common diagnosis. 98.69% and 96.23% was the sensitivity and specificity of the diagnostic strategy used in this study to identify ADHF. A significant ($p<0.01$) proportion of patients presenting with dyspnea had Presence of ARDS with ADHF.
Conclusion: Incorporating POCUS by lung-cardiac-IVC into routine clinical evaluation yielded a higher accuracy in differentiating causes of dyspnea in ED, and hence this diagnostic strategy could be recommended even in resource-limited setting.

Introduction:-

Dyspnea, which is defined as a subjective inability to breathe comfortably, is a common primary complaint among patients in the emergency department (ED).[1] Common causes include Pneumonia, Decompensated heart failure, ARDS, Pleural effusion and pulmonary embolism. The rapid and accurate differentiation of the causes of dyspnea are especially challenging. To compound the problem, there are limitations to the current diagnostic tools. For

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example, chest radiography has moderately low sensitivity and specificity in diagnosing pulmonary edema, COPD, pleural effusion and pneumothorax.[2] Arterial blood gas evaluation, though frequently sampled in patients presenting with acute dyspnea, has been shown to perform poorly in differentiating between cardiac and respiratory causes of dyspnea.[3] The diagnostic value of B-type natriuretic peptide and N-terminal pro brain natriuretic peptide in heart failure also has low specificity.[4] Furthermore, results of these investigations require time and may be less useful in patients with acutely worsening dyspnea who require emergency therapy based on preliminary assessment.[5]

In view of these limitations, lung ultrasonography has increasingly emerged as a useful point-of-care tool in evaluating these patients due to its rapid, non-invasive, repeatable and non-ionising characteristics.[6] Recent studies have also demonstrated its high sensitivity and specificity in the diagnosis of decompensated heart failure,[7] pneumonia,[8] pneumothorax,[9] pulmonary embolism,[10] and pleural effusion.[11]

However, most of the studies reported in literature focussed on assessing the diagnostic performance of USG in identifying ADHF patients presenting with dyspnea to ED, leaving behind non-cardiac causes of dyspnea, thereby necessitating a strategy to differentiate various non-cardiac causes of dyspnea, and very few studies were performed in resource-limited ED setting. Moreoverdyspnea is a common ED presentation. A study in Boston, demonstrated that 23% of all admitted ED patients reported withdyspnea in the past 24 hours, and 11% reported dyspnea within 12 hours after admission.[12]

With these viewpoints our study was conducted with the main purpose of assessing a diagnostic strategy usingpoint of care ultrasonography (POCUS) to distinguish patients presenting with acute dyspnea to ED into different diagnostic categories for timely management in a resource-limited setting.

Methodology:-

Study design and setting

This was a prospective cohort study conducted in the department of Emergency Medicine from 1/7/2021 to 1/9/2022 atBapuji hospital J. J. M Medical College, Davangere, Karnataka. To assess the diagnostic accuracy of using POCUS in evaluating patients presenting with dyspneato ED. A written informed consent was obtained from all patients.

Inclusion criteria

1. Patients aged 18 years and above
2. Patients able to provide valid informed consent
3. Patients presenting with dyspnea as predominant complaint

Exclusion criteria

1. Patients aged below 18 years
2. Patients unable to provide valid informed consent

Patient evaluation

Patient's medical history, vital signs, and systemic examination were recorded by the enrolling physician. Dyspnea at admission was measured using a 5-point LIKERT scale in sitting position. All patients underwent routine tests as part of the hospital protocol (ECG, chest X-ray, and lab investigations).

Point-of-care USG

After initial evaluation, all patients were subjected to a focused point of care ultrasonography at bedside using a standard medium frequency curved array probe which includes the following

Cardiac USG:

Parasternal long- and short-axis views—left ventricular ejection fraction (EF) was estimated visually in the parasternal long-axis view by wall contraction and thickening. EF was confirmed in the parasternal short-axis view at the level of the papillary muscles. Mitral valve E-point septal separation (EPSS) is the distance from the anterior mitral valve leaflet, and the ventricular septum in early diastole measured in M mode is also noted in every patient. Left ventricular systolic function was typically graded as normal (EF > 50%), moderate dysfunction (EF 30–50%), or severe dysfunction (EF < 30%) based on eyeball visual estimate and EPSS measurement. A qualitative evaluation of the right ventricle (RV) dimension was made for RA/RV dilatation, considering RV/LV-end diastolic diameter> 0.9 in the Apical four chamber view as abnormal.

Lung USG:

Lung USG was performed on each hemithorax divided into four zones (two anterior, two laterals) with patient in seated or lying down position. Several signs were explored to conclude on typical patterns as per the international evidence-based recommendations on point-of-care lungUSG,[14,15]which includes lung sliding, pleural effusion (anechoic space between parietal and visceral pleura with sinusoid sign), pneumothorax (loss of lung sliding with positive lung point), and acute interstitial syndrome (AIS), defined as B-pattern with at least three B-lines in two lung zones bilaterally and lung consolidation signs (focal B-lines with tissue-like echotexture and dynamic air bronchograms).(Figure 1 and Figure 2).[14,15,16]

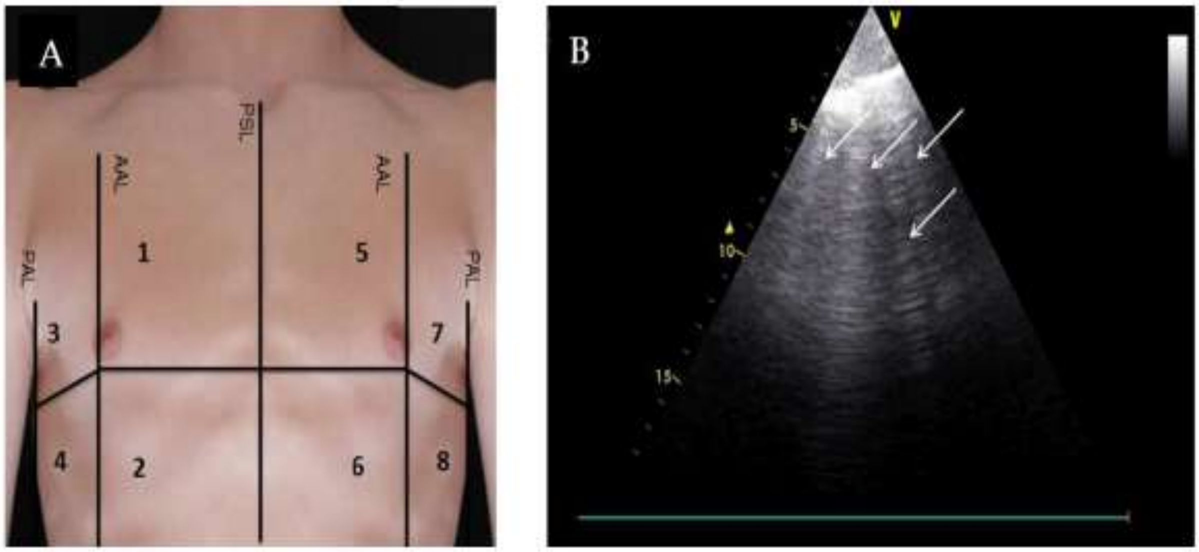

Figure 1:- [A] Division of the thorax in eight lung zones. PSL: parasternal line; AAL: anterior axillary line; PAL: posterior axillary line; **[B]** Example of a lung ultrasound loop of quadrant 1 at admission assessed as a positive region due to the appearance of ≥ 3 B-lines.

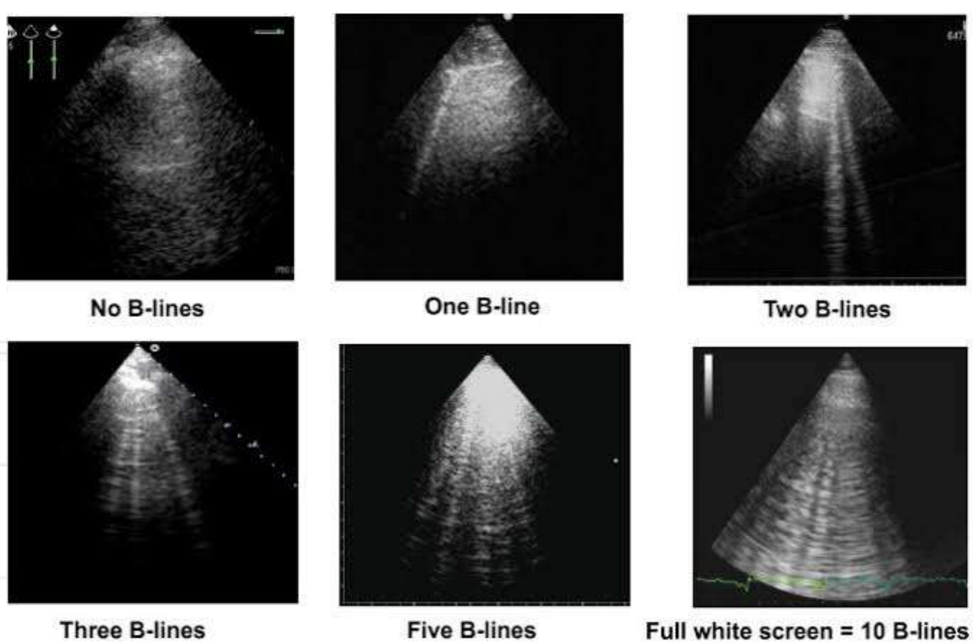

Figure 2:- Showing lung USG signs.

IVC USG:
IVC USG was performed in sub-xiphoid view for diameter and collapsibility. An IVC with a maximal diameter of ≥2 cm and < 50% collapse was considered plethoric. An IVC with a maximal diameter of ≤ 2 cm and > 50% collapse was considered collapsible.

After a complete assessment, patients were assigned into one of the eight clinical syndromes defined as mentioned in Table 1 by following the constructed algorithm mentioned in Figure 3. Patient's time for improvement in their symptom status was noted.

Table 1:- Clinical syndromes based on USG patterns and clinical variables.

ADHF (Systolic dysfunction)	LV dysfunction on cardiac USG with presence of multiple diffuse bilateral B-lines in lung USG
Diastolic Heart Failure	Normal LV function with LV hypertrophy (LVH), left atrial enlargement, multiple diffuse bilateral B-lines, dilated IVC, with abnormal E-A ratio
Acute pneumonia	Lung USG showing focal B-lines, tissue-like echotexture and dynamic air bronchogram with normal LV function.
ARDS	Presence of multiple diffuse bilateral B-lines in non-homogenous distribution,normal LV function with clinical presentation suggestive of sepsis.
Pneumothorax	Normal LV function, absent lung sliding with positive lung point and suggestive clinical picture.
Tamponade	Normal LV function, pericardial effusion with dilated and non-collapsible IVC with suggestive clinical signs.
Volume overload	Normal LV function, normal RV, multiple diffuse bilateral B-lines, dilated IVC.
Acute Pulmonary Embolism	Normal LV function, dilated RA/RV, normal lung USG with high pre-test probability of PE.

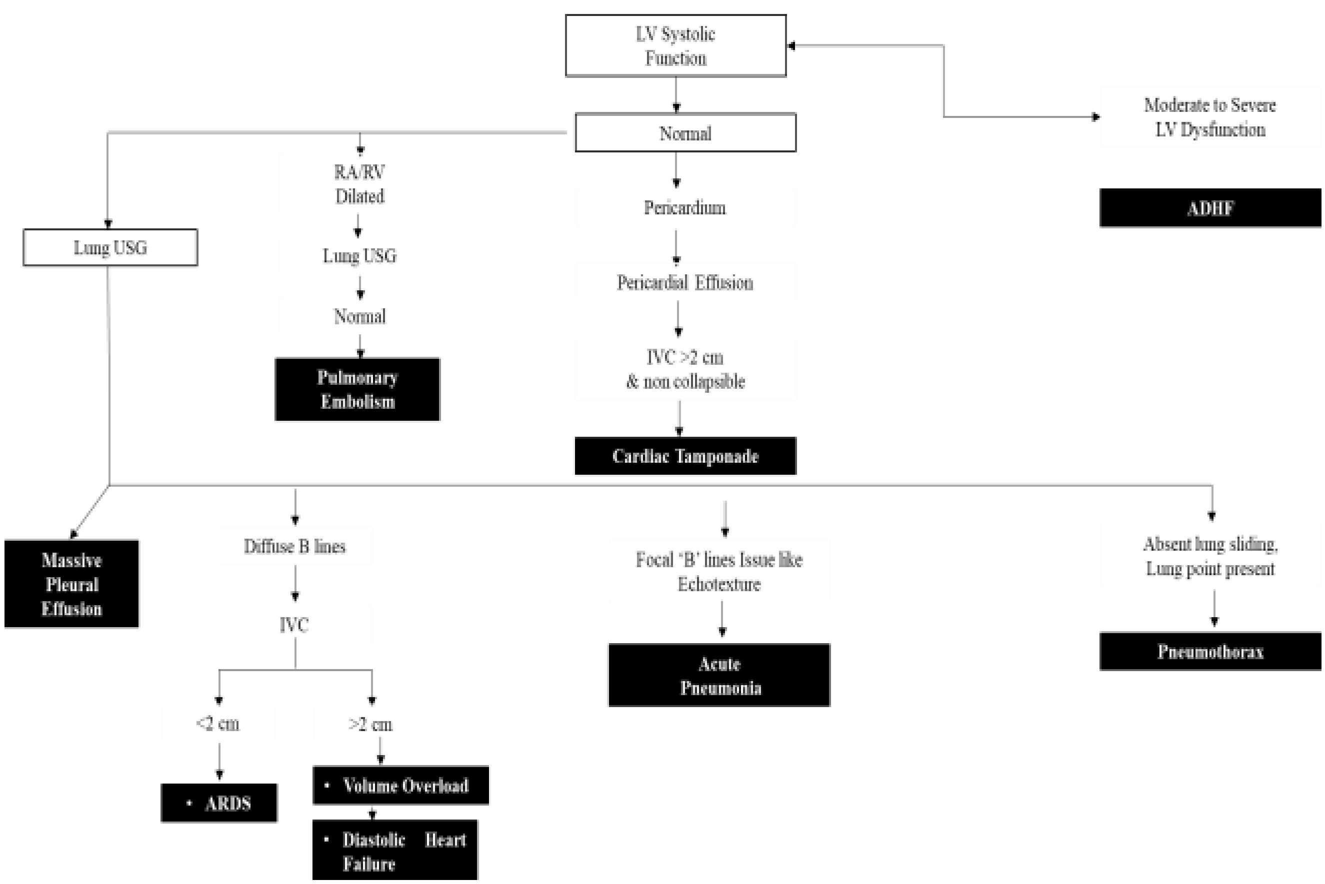

Figure 3:- Showing dyspnea diagnostic algorithm.

The final hospital diagnosis of patients were determined by independent physicians and a cardiologistusing the reference standard definition for heart failure and pulmonary diseases inaccordancewith routine standard evaluation using chest X-ray, echocardiographic examination, cardiac functional assessment (exercise test), full blood count, biochemistry, and invasive investigation(CT-PA) or angiography without knowledge of the USG data collected in ED. The initial ED diagnosis is compared with final hospital diagnosis as mentioned on discharge sheet.

Statistical analysis

The comparison of the group of patients who have cardiac and non-cardiac diagnosis was done using Student's t test and chi-square test for continuous and categorical variables, respectively. The performance of different diagnostic tools was analyzed using sensitivity and specificity analysis. The level of agreement between ED diagnosis and final hospital diagnosis was assessed using Cohen's Kappatest. All data were analyzed using the SPSS v.21.0.0 software package. p-value < 0.05 is considered as statistically significant.

Results:-

Out of total 50 patients, majority were diagnosed as ADHF in ED followed by ARDS , Presence of ARDS with ADHF & acute pulmonary embolism . In our study 2 out of 20 ADHF, 2 out of 8 ARDS, 2 out of 6 Presence of ARDS with ADHF and 1 out of 5 Acute pulmonary embolismpatientswereincorrectlydiagnosed asARDS/Volumeoverload, Bronchopneumonia, ADHF/ARDS, and Pleural effusion respectively in ED(Table 2).

Table 2:- Distribution of patients based on diagnostic category.

ED Diagnosis	No. of Patients	No. of Incorrect ED Diagnosis	Final discharge diagnosis of incorrect ED diagnosis cases
ADHF (Systolic or diastolic heart failure)	20	2	ARDS/Volume Overload
Volume overload (AKI, CKD)	4	Nil	-
Presence of ARDS with ADHF	6	2	ADHF/ARDS
ARDS	8	2	Bronchopneumonia
Acute Pulmonary Embolism	5	1	Pleural effusion
Massive pleural effusion	2	Nil	-
Acute pneumonia	3	Nil	-
Pneumothorax	2	Nil	-

Discussion:-

Our study findings revealed that 43 out of 50 patients (86%) were treated as per disease-specific treatment using the above diagnostic strategy with agreement of ED diagnosis and final discharge diagnosis. The measure of agreement Kappa is 0.798 (p<0.001). Most of the differences occurred in patients with ARDS and Presence of ARDS with ADHF,they were incorrectly diagnosed as Bronchopneumonia and ADHF/ARDS respectively.

The most common diagnosis for dyspnea in our study was ADHF (40%). Sensitivity and specificity of the diagnostic strategy used in our study to identify ADHF was 98.69 and 96.23% respectively. In consistency with our study findings,Kajimoto et al., found a sensitivity and specificity of 94 and 91%,[17]and Russell et al., reported sensitivity and specificity of 83 and 83%.[18]As opposed to the more comprehensive and time-consuming echocardiography protocols used byothers,[19,20]the echocardiography component of our study protocol simply focused on ejection fraction by gross visual estimation(an adopted method by ACEP for emergency cardiac USGto assess global LV systolic function),[21] presence or absence of pericardial effusion, and right ventricular enlargement, while in previous studiesthey evaluated diastolic function and Doppler evaluation of the heart. To diagnose diastolic heart failure, we have taken a set of parameters like LVH, LA enlargement, bilateral B-lines on lung USG, and dilated IVC, abnormal E-A ratio. Similarly, the lung examination consisted of assessment of eight zones bilaterally. We have attained similar sensitivity and specificity using this abbreviated protocol. Not only is such an abbreviated protocol feasible during initial resuscitation of the sickest dyspneic patients, but it is likely to be more generalizable to non-expert sonographers across all settings.

To date, there have been just a few studies evaluatingdyspnea presenting to ED using POCUS protocol similar to our study combining abbreviated echocardiography, lung USG, and IVCassessment.[17,18] A significant proportion of our patients presenting with dyspnea had both cardiac and non-cardiac causes. There is a significant increase in morbidity in these patients compared to patients with single cause of dyspnea with increase in duration to relief of dyspnea, and hospital stay (mean 15 days). So, it is important to have comprehensive search for all the major causes of dyspnea in every patient as significant number of them could be having multiple disease processes responsible for their symptoms.

Our study has limitations, the first being a small sample size. Patients were enrolled by a single physician trained in ultrasonography. All consecutive patients presenting with dyspnea to ED were not enrolled limited by the availability of enrolling physician. Because of the small sample size, some causes of dyspnea resulted in low recurrence, limiting the reproducibility of data relative to the ability of ultrasound in detecting them. The ED physician sonographer could be influenced by a suggestive clinical presentation as the sonographer is not blinded to patient clinical findings. The primary endpoint was the diagnosis on the patient discharge summary. Although the analysis has been made by independent physicians and a cardiologist, this criterion could be questionable because the final diagnosis was based on a body of evidence including ED diagnosis.

Conclusion:-

Incorporating POCUS by lung-cardiac-IVC into routine clinical evaluation yielded a higher accuracy in differentiating causes of dyspnea in ED, and hence this diagnostic strategy could be recommended even in resource-limited setting.

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