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IMPACT OF BLUE PROTOCOL TO DIFFERENTIATE BREATHLESSNESS IN EMERGENCY MEDICINE

Emergency Medicine

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ABSTRACT

Dyspnea, a common symptom in Emergency Departments (EDs), necessitates prompt diagnosis. The Bedside Lung Ultrasonography in Emergency (BLUE) protocol offers a rapid, non-invasive diagnostic approach for acute dyspnea. Utilizing a simple ultrasound machine with standardized analysis points, it requires minimal training. By assessing 10 signs related to various lung conditions, the protocol facilitates a step-by-step diagnosis based on pathophysiology. This study aims to compare initial BLUE protocol results with clinical diagnoses to demonstrate its potential in expediting treatment in ED settings. The study, conducted over one year enrolled 200 ED patients experiencing breathlessness. Data were collected using decoder sheets and patient records. Participants, both genders aged above 18 years, provided informed consent. Exclusion criteria included inability or unwillingness to consent, lack of definitive diagnosis, and rare conditions. Results showed impressive ultrasound accuracy rates across various conditions. Sensitivity for pulmonary edema, COPD, asthma, pulmonary embolism, and pneumothorax ranged from 88.23% to 97.46%. Pneumonia sensitivity reached 96.875%. These findings underscore ultrasound's efficacy in diagnosing diverse respiratory conditions. The study concludes that the BLUE protocol is reliable for assessing dyspneic ED patients. It recommends adapting the protocol for evaluating pleural and pericardial effusions to enhance diagnostic effectiveness in EDs.

KEYWORDS

Dyspnea, Emergency Medicine, BLUE Protocol, Ultrasound, Diagnosis

INTRODUCTION

The BLUE2 (Bedside Lung Ultrasonography in Emergency) protocol, developed by Lichtenstein, offers a systematic approach to diagnosing dyspneic patients in intensive care units (ICUs) with impressive 90.5% diagnostic accuracy. While originally designed for ICUs, the protocol is now gaining recognition for its potential in emergency settings [1, 2]. Dyspnea, or shortness of breath, is a prevalent symptom with diverse underlying causes, ranging from respiratory and cardiac issues to neuromuscular and psychogenic factors. It can manifest acutely or chronically, impacting millions worldwide [3, 4].

Dyspnea stems from respiratory, cardiac, neuromuscular, and psychogenic origins, often intertwined with systemic illnesses. Respiratory causes include asthma, COPD exacerbations, pneumonia, pulmonary embolism, pneumothorax, and lung malignancies. Cardiac etiologies involve congestive heart failure, pulmonary edema, acute coronary syndrome, and valvular defects, among others. Neuromuscular factors encompass chest trauma, obesity, central nervous system disorders, and myopathies, while psychogenic causes can arise from anxiety disorders or vocal cord dysfunction. Additionally, systemic illnesses like anemia, renal failure, metabolic acidosis, and sepsis contribute to dyspnea [5, 6, 7].

Epidemiologically, dyspnea prevalence exceeds 20%, influenced by factors like cardiopulmonary diseases, lifestyle, obesity, and subclinical conditions. Specific conditions exhibit varying prevalence rates, with cancer, COPD, cardiac failure, end-stage renal disease, and advanced neurological disease presenting high prevalence rates [8, 9]. As patients near the end of life, dyspnea prevalence and intensity often increase, significantly impacting their quality of life and necessitating medical intervention.

The anatomy of the lungs plays a crucial role in understanding dyspnea. Lungs, divided into lobes and segments, facilitate gas exchange through alveoli and bronchioles. Lung ultrasound emerges as a valuable tool in diagnosing dyspnea, offering non-invasive, rapid assessment at the bedside. TheBLUE protocol, employing standardized ultrasound points and analysis, systematically evaluates lung conditions associated with dyspnea, achieving high sensitivity for various respiratory pathologies [10].

Dyspnea arises from complex interactions between the central nervous system, peripheral chemoreceptors, and mechanoreceptors in the respiratory system. Assessment involves various instruments and diagnostic tests, with lung ultrasound gaining prominence for its efficiency and accuracy in diagnosing dyspnea, especially in emergency settings [11, 12].

Aims & Objectives

This study aimed to study the utility of BLUE PROTOCOL for the evaluation of patients presenting with dyspnea in the ER.

MATERIALS AND METHODS

This single-centered prospective observational study was conducted at tertiary hospital, Trivandrum, known for its state-of-the-art facilities and round-the-clock medical and surgical emergency services. The study spanned one year, from December 2022 to December 2023. The sample size of approximately 200 patients presenting with breathlessness was determined using the formula N = 4pq/d^2, where p is the prevalence, q is 100-p, and d is the absolute precision set at 5%. The study focused on assessing artifacts (such as horizontal A lines or vertical B lines indicating interstitial syndrome), lung sliding, and alveolar consolidation and/or pleural effusion using the BLUE protocol, without interrupting the management protocol. Diagnoses were confirmed through standardized tests by other clinicians as documented in hospitalization reports. Inclusion criteria encompassed

patients with dyspnea aged 18 years and above, while exclusion criteria included patients without a definitive diagnosis or those with rare diagnoses.

RESULTS

This study included 200 participants, with 29% aged between 65-74 years old and 60.5% being male. Among the participants, 41% presented with Pulmonary edema, while 40% exhibited B line + and Dilated IVC according to the Blue - protocol. Chest examination revealed bilateral Creps + in 36% of cases. Additionally, 23% of participants had comorbidities such as CAD, T2DM, or HTN (Table 1).

Statistically significant relationships were identified between certain medical conditions and diagnostic indicators in our study. Specifically, we found a significant association between Pneumonia and the presence of A profile + and PLAPS (consolidation+) (p = 0.034), as well as between Pulmonary edema and the presence of B lines + and Dilated IVC (p = 0.009). However, no statistically significant relationship was observed between COPD/Asthma and the presence of A profile or absence of plaps point (p = 0.067). Conversely, a significant statistical relationship was detected between Pulmonary Embolism and the presence of A Profile and Thrombosed veins (p = 0.009). Interestingly, no statistically significant relationship was found between Pneumothorax and the absence of Lung sliding and M mode (Barcode sign) (p = 0.284). These findings shed light on the diagnostic value of various indicators in identifying these medical conditions (Table 2).

Ultrasound Accuracy Rates For pulmonary edema, the B profile had 97.46% sensitivity. For COPD and asthma (considered together for purposes of simplicity), the normal profile had a 96.59% % sensitivity. For pulmonary embolism, the A profile plus venous thrombosis showed 88.23% sensitivity. For pneumothorax, absent anterior lung sliding, anterior A lines, and a positive search for lung point yielded 87.5% sensitivity. For pneumonia, sensitivity is, respectively, 96.875% the A profile plus PLAPS (Table2).

Lung ultrasound immediately provided diagnosis of acute respiratory failure in 93.27% of cases. It can therefore be added to the armamentarium of Emergency Medicine. Theadditional value of saving time should provide prompter relief for these severely dyspneic patients.

Table 1: Demographic Distribution

Demographic data		Frequency	Percent (%)
Overall		200	100
Age	45 and below	29	14.5
	45 - 54	31	15.5
	55 - 64	54	27.0
	65 - 74	58	29.0
	75 and above	28	14.0
Gender	Male	121	60.5
	Female	79	39.5
Mechanism of Dyspnea	Pneumonia	34	17
	Pulmonary edema	82	41
	COPD/Asthama	57	28.5
	Pulmonary Embolism	18	9
	Pneumothorox	9	4.5
Profiles of Blue - protocol	A profile +, PLAPS (consolidation+)+	36	18
	B lines +, Dilated IVC	80	40
	A profile, No plaps point	59	29.5
	A Profile, Thrombosed veins	18	9
	Lung sliding absent, M mode (Barcode sign (R))	7	3.5
Chest examination findings	B/l Creps +	72	36
	B/l Decrease breath sounds, B/l scattered creps+	32	16
	B/l Wheeze +	53	26.5
	Coarse Creps (Right)+	26	13
	Decreased breath sound (R), Wheeze +	9	4.5
	NVBS	8	4
Comorbidities	BA	8	4
	CAD, T2DM/ HTN	46	23
	CKD, HTN	20	10
	DLP	16	8
	HTN	10	5
	HTN, BPH, COPD	10	5
	Nil	10	5
	T2DM, HTN	80	40

Table 2—Accuracy of the Ultrasound Profiles with P Value*

Mechanism of Dyspnea	Profiles of Blue - protocol	Sensitivity, %	Specificity, %	Positive Predictive Value,%	Negative Predictive Value, %	Diagnostic Accuracy, %	P-Value
Pneumonia	A profile +, PLAPS (consolidation+)+	96.78	33.34	93.75	50	91.18	0.034
Pulmonary edema	B lines +, Dilated IVC	98.70	20	95	50	93.90	0.009
COPD/Ast hma	A profile, No plaps point	94.44	33.33	96.22	25	91.23	0.067
Pulmonar	A Profile, Thrombosed veins	93.53	33.33	87.5	50	83.33	0.009
Pneumotho rax	Lung sliding absent, M mode (Barcode sign)	85.71	50	85.71	50	77.78	0.284

DISCUSSION

This study assesses the applicability of the BLUE protocol, initially designed for dyspnea in Intensive Care Units (ICUs), in Emergency Departments (EDs). The BLUE protocol demonstrated a 93.19% mean diagnostic accuracy for acute dyspnea across diverse ED cases, slightly lower than Lichtenstein's original study (90.5%) [13]. ED patients presented a broader spectrum of diagnoses, including lower respiratory infections, pleural/pericardial effusions, acute coronary syndrome, anemia, anxiety, and neuromuscular diseases, expanding beyond the BLUE protocol's original scope (pulmonary edema, pneumonia, pulmonary embolism, pneumothorax, and asthma/COPD). However, lung ultrasound effectively differentiated crucial pathologies like pulmonary edema, pneumonia, and pneumothorax in the ED.

Despite limitations, the BLUE protocol proves valuable for the differential diagnosis of dyspneic patients in both ED and ICU settings. Notably, the evaluation of pleural andpericardial effusions contributes significantly to diagnostic accuracy. Challenges include the protocol's difficulty in detecting pathologies where primary lung parenchyma is unaffected, leading to misdiagnoses, especially in cases of bronchitis, acute coronary syndrome, anemia, anxiety, and neuromuscular diseases. Nevertheless, the absence of parenchymal disease demonstrated by Lung Ultrasound (LUS) can provide valuable diagnostic insights.

The study recommends an enhanced "BLUE plus" protocol for investigating additional diagnoses before conclusively diagnosing asthma/COPD, particularly for patients presenting with dyspnea to the ED and exhibiting the A profile in LUS [14]. While the BLUE protocol defines patients with no lung pathology (A profile) as asthma or COPD, this study highlights the need for supplementary investigations, given the diverse conditions associated with this profile.

Comparisons with other studies, such as those by Lichtenstein et al., Zanobetti et al., and Laursen, underscore the BLUE protocol's versatility [15, 16]. The study by Laursen, evaluating undifferentiated dyspnea in the ED, reported an 88% sensitivity for the final diagnosis. However, the study's inclusion criteria differed from this research. In our study, all consecutive ED patients with dyspnea complaints were included, achieving a higher sensitivity (Mean 93.27%). These findings collectively support the continued exploration and refinement of the BLUE protocol for comprehensive dyspnea assessment in EDs.

CONCLUSION

The BLUE protocol, initially designed for intensive care patients, demonstrates confident applicability in assessing acute dyspneic Emergency Department (ED) patients, particularly for pulmonary edema, pneumothorax, pneumonia, and pulmonary embolism. However, a key finding in our study underscores potential limitations in the BLUE protocol's sensitivity and specificity for diagnosing asthma/COPD in ED patients with acute dyspnea. This necessitates further diagnostic exploration within the asthma/COPD context. To enhance the BLUE protocol's diagnostic utility in ED settings, modification is recommended, specifically addressing the assessment of pleural and pericardial effusions.

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