ORIGINAL RESEARCH PAPER
Volume - 14 | Issue - 08 | August - 2025 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

ROLE OF BEDSIDE LUNG ULTRASOUND IN EMERGENCY (BLUE) PROTOCOL IN CRITICALLY ILL PATIENTS AND CORRELATION WITH CHEST RADIOGRAPHY

Radio-Diagnosis

Dr. Anushka Patil* Junior Resident, Radiodiagnosis J.J.M Medical College, Davangere, Karnataka *Corresponding Author

Dr. Jay T Chauhan Junior Resident, Radiodiagnosis J.J.M Medical College, Davangere, Karnataka

Dr. Jeevika M U Professor & HOD, Dept Of Radiodiagnosis J.J.M Medical College, Davangere, Karnataka

ABSTRACT

BLUE-protocol is a valuable diagnostic tool in critically ill patients focusing on rapid assessment of lung conditions using ultrasound which aids in quick clinical decisions. It provides real-time lung imaging and is portable compared to radiography. This study attempts in comparing routinely used chest radiography to BLUE-protocol in assessing efficacy, reliability and timely intervention in critically ill patients. This study demonstrates role of lung ultrasound in early diagnosis and management of critically ill patients and correlate findings with routine chest radiograph concerning diagnosis, time efficacy and patient management. We included critically ill patients with respiratory complaints and hemodynamic instability in our study. Ultrasonography using BLUE protocol was conducted to assess lung sliding, B line, pleural effusion and consolidation and interpreting them using A-line, B-line and C-profile as per the protocol. Routine chest radiographs of patients were taken and findings were compared with ultrasonography along with clinical correlation. The study demonstrates the high sensitivity and specificity of the BLUE Protocol in diagnosing critical conditions like pneumothorax and pleural effusion. It also highlights the superior diagnostic reliability of the BLUE Protocol in detecting subtle and minimal findings compared to radiography. The study also confirmed the time efficiency of the BLUE Protocol, enabling quicker diagnosis and interventions. BLUE-protocol offers effective clinical decision making in critically ill patients due to its versatility and quick assessment. BLUE-protocol in conjunction to chest radiography in critical care scenarios enhances diagnostic efficacy.

KEYWORDS

BLUE protocol, chest radiography, critically ill patients, diagnostic efficacy, time efficacy

INTRODUCTION

BLUE (Bedside lung ultrasound in emergency) -protocol is a valuable diagnostic tool in critically ill patients which focuses on rapid assessment of lung conditions using ultrasound which aids in quick clinical decisions. It provides real-time lung imaging and is portable compared to traditional chest radiography. This study attempts in comparing the routinely used chest radiography to BLUE-protocol in assessing the efficacy, reliability and timely intervention in critically ill patients.

This was a comparative study conducted at a tertiary care center over 6 months. The study group was critically ill patients with respiratory complaints such as breathlessness, cough with expectoration and hemodynamic instability based on clinical examination, vital signs, ECG and troponin levels. The patients were clinical referrals by department of emergency medicine in our institution for chest radiographs and SOS ultrasonography of thorax. BLUE protocol was used to assess the thorax. It focuses on rapid assessment of lung conditions using ultrasound aiding in prompt clinical decisions. 43 patients were included in this study. Routine chest radiographs of the patients were taken and findings were compared with ultrasonography along with clinical correlation. Plain bedside portable chest AP radiograph were taken in supine position trying to maintain adequate exposure and positioning. In the BLUE-protocol, three standardized points are the upper BLUE-point, lower BLUE-point and PLAPS-point.

Seven Principles Of Lung Ultrasound

- Lung (and critical) ultrasound is performed at best using simple equipment.
- In the thorax, gas and fluids have opposite locations, or are mingled by pathologic processes, generating artifacts.
- The lung is the most voluminous organ. Standardized areas can be defined.
- All signs arise from the pleural line.
- Static signs are mainly artifactual.
- The lung is a vital organ. The signs arising from the pleural line are foremost dynamic.
- Almost all acute life-threatening disorders abut the pleural line, explaining the potential of lung ultrasound.

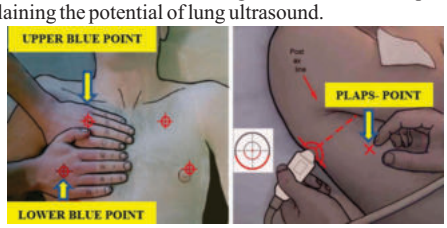


Figure 1- Probe positions for BLUE-protocol lung ultrasound: Anterior chest points for lung sliding and B-line evaluation (left), and posterolateral point for pleural effusion or consolidation detection (right).

Note: Adapted from Lung ultrasound in the critically ill by D. A. Lichtenstein, 2014, Annals of Intensive Care, 4(1), Article 1. https://doi.org/10.1186/2110-5820-4-1. Licensed under CC BY 2.0.

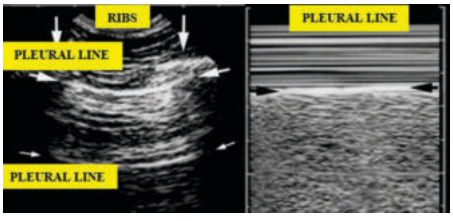


Figure 2- Normal lung surface. Left: Intercostal scan showing ribs, pleural line (bat sign), and A-lines—indicating air-filled lung. Right: M-mode showing seashore sign, confirming lung sliding and visceral pleura contact. Together, these define the A-profile.

Note: Adapted from Lung ultrasound in the critically ill by D. A. Lichtenstein, 2014, Annals of Intensive Care, 4(1), Article 1. https://doi.org/10.1186/2110-5820-4-1. Licensed under CC BY 2.0.

The BLUE-protocol combines signs, associates them with a location, resulting in seven profiles

1. **The A-profile** associates anterior lung-sliding with A-lines.
2. **The A'-profile** is an A-profile with abolished lung-sliding.
3. **The B-profile** associates anterior lung-sliding with lung-rockets.
4. **The B'-profile** is a B-profile with abolished lung-sliding.
5. **The C-profile** indicates anterior lung consolidation, regardless of size and number. A thickened, irregular pleural line is an equivalent.
6. **The A/B profile** is a half A-profile at one lung, a half B-profile at another.
7. **The PLAPS-profile** designates Postero-Lateral Alveolar and/or Pleural Syndrome detection of an A-profile (a pattern compatible with pulmonary embolism) and of a free venous network (a pattern making the diagnosis of embolism less likely). The profile combining A-profile, free veins, and PLAPS is called **A-V-PLAPS-profile.**
8. Fluid in the pleural cavity such as pleural effusion and hemothorax (associated finding with the above-mentioned conditions) is not a

part of the BLUE protocol.

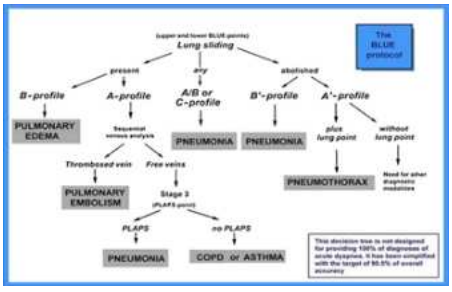


Figure 3- The BLUE-protocol decision tree for the immediate diagnosis of acute respiratory failure using lung and venous ultrasound.

Note: Adapted from Lung ultrasound in the critically ill by D. A. Lichtenstein, 2014, Annals of Intensive Care, 4(1), Article 1. https://doi.org/10.1186/2110-5820-4-1. Licensed under CC BY 2.0.

ANALYSIS AND RESULTS

Out of 43 patients, 29 were men and 14 were women. 5 patients were in 20 – 30 years age group, 9 patients were in 31 – 40 age group, 10 patients were in 41 – 50 age group, 13 patients were in 51-60 age group and 6 patients were in 61-70 age group.

Table – 1 General Details

Final diagnosis		Correctly diagnosed on Lung ultrasonography	Correctly diagnosed on Chest radiography
Pneumothorax (N=12)		12	09
Pleural effusion/ Hemothorax (N=10)		10	06
Consolidation (N=13)	Patchy	02	00
	Lobar	11	11
Pulmonary edema (N=3)		00	03
COPD/Asthma (N=3)		00	03
Pulmonary thromboembolism (N=2)		00	00

Table 2 Diagnostic Accuracy Of Blue Protocol And Chest Radiography (N=43)

Condition	Discrepancy type	BLUE Protocol (N)	Chest Radiography (N)
Pneumothorax (N=12)	Subtle missed findings	00	03
Pleural effusion/ Hemothorax (N=10)	Minimal pleural fluid missed	00	02
	Diagnosed as consolidation	00	02

Pneumothorax: BLUE Protocol correctly identified all 12 cases, whereas Chest Radiography missed 3 cases with subtle findings.

Pleural Effusion: BLUE Protocol identified 10 cases, including 2 minimal pleural fluids missed by radiography. 2 cases misdiagnosed as pleural effusion on radiograph were correctly diagnosed as consolidation on ultrasonography.

Lobar Consolidation: Both modalities performed equally well, with no discrepancies. However patchy consolidation was missed on radiographs which were picked up on ultrasonography.

This table supports the objective of correlating findings and highlights the higher sensitivity of the BLUE Protocol in certain conditions.

Table 2 demonstrates the high sensitivity and specificity of the BLUE Protocol in diagnosing critical conditions like pneumothorax and pleural effusion.

Table 3 Diagnostic Discrepancies Between Blue Protocol And Chest Radiography (N=43)

Diagnostic test	Average Time to Diagnosis (Minutes)
BLUE protocol	05
Chest radiography	15

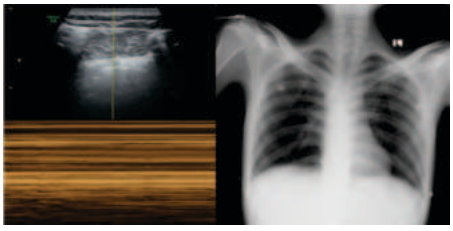
BLUE Protocol detected all conditions, whereas Chest Radiography had 5 missed or misdiagnosed cases. This highlights the reliability of the BLUE Protocol in detecting subtle or minimal findings. Table 2 and Table 3 together highlight the superior diagnostic reliability of the BLUE Protocol in detecting subtle and minimal findings compared to radiography.

Table – 4 Time Efficiency Of Diagnostic Modalities (N=43)

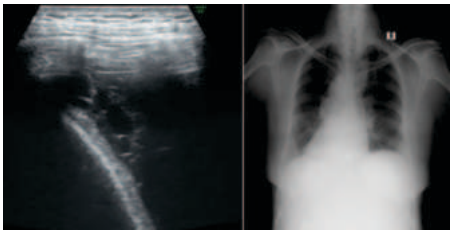
Condition	Diagnostic Test	True Positive	False Negative	Sensitivity (%)	Specificity (%)
Pneumo-thorax	BLUE Protocol	12	00	100.0	100.0
	Chest Radiograph	09	03	75.0	75.0
Pleural Effusion or Hemo-thorax	BLUE Protocol	10	00	100.0	100.0
	Chest Radiograph	08	02	80.0	80.0
Lobar Consolidation	Both modalities	11	00	100.0	100.0

BLUE Protocol is significantly faster than Chest Radiography, supporting the objective of timely intervention in critically ill patients, enabling quicker diagnosis and interventions.

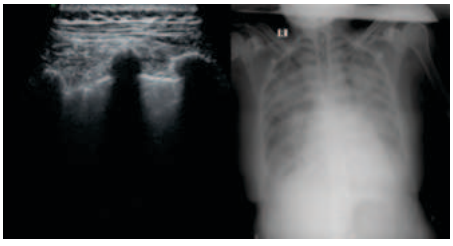
Case Study



Case 1: Pneumothorax diagnosed on ultrasonography missed on radiograph.



Case 2: Minimal pleural effusion diagnosed on ultrasonography missed on radiography.



Case 3: Pulmonary edema diagnosed on radiograph missed on ultrasonography.

This study demonstrates the high sensitivity and specificity of the BLUE Protocol in diagnosing critical conditions like pneumothorax and pleural effusion. This study highlights the superior diagnostic reliability of the BLUE Protocol in detecting subtle and minimal findings compared to radiography. Chest radiograph diagnosed all cases of pulmonary edema and COPD/Asthma whereas ultrasonography diagnosed none. However, clinical correlation was needed for appropriate diagnosis. As portable radiographs are taken in AP projection at bedside with often the patients being non co-operative, there were higher chances of inadequate exposure and improper positioning affecting the accuracy of diagnosis. Pulmonary thromboembolism was not diagnosed either on ultrasonography or radiography, demonstrating low sensitivity and specificity. BLUE protocol includes the assessment of lower limb venous system for deep venous thrombosis in its diagnostic algorithm. However all the cases (N=2) included this study had a normal complementary lower limb venous Doppler study. A higher modality (CT-Pulmonary angiogram)

is needed along with high clinical suspicion to diagnose pulmonary thromboembolsim. BLUE Protocol supplemented with chest radiograph enables quicker and appropriate diagnosis as well as timely interventions.

CONCLUSIONS

BLUE-protocol offers effective clinical decision making in critically ill patients due to its versatility and quick assessment.
BLUE-protocol in conjunction to chest radiography in critical care scenarios enhances diagnostic efficacy.

REFERENCES:

[1] Lichtenstein DA, Mezière GA. Relevance of lung ultrasound in the diagnosis of acute respiratory failure: the BLUE protocol. Chest. 2008;134(1):117–25. doi:10.1378/chest.07-2800.
[2] Lichtenstein DA. Lung ultrasound in the assessment of acute respiratory failure. Ann Intensive Care. 2014;4(1):1. doi:10.1186/2110-5820-4-1.