Lung Ultrasound

Maurizio Galderisi
Head, Cardiovascular Emergencies and Onco-Haematological Complications
Laboratory of Standard and Advanced Echocardiography
Federico II University Hospital

Vice President, EACVI
Communication Officer, ESC Council of Cardio-Oncology
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OBJECTIVES

1.- To show the diagnostic capabilities of Lung UltraSound in Critical Care.
2.- To illustrate the diagnostic modalities needed.
3.- To highlight the fields of application.
4.- To encourage the use of standardized protocols and terminology.
Lung Approach in Critical Care

• Physical examination: insufficient for fine diagnosis
• Bedside chest radiography: limited accuracy
• Chest computed tomography: risk of transportation and limited availability
• Lung UltraSound (LUS): Easy available, Low cost
Lung Ultrasound (LUS) In Emergency

When LUS can be useful in ER:

- Pleural pathology
- Pericardial pathology
- Shortness of breath
- Cianosis
- Cough
- Shock
Probes for Lung Ultrasound (LUS)

- Sector probe
- Convex probe
- Linear probe
LUS approach standardization

The blue points

Each point shows a standardized area for a given disorder

Longitudinal or Transversal Approach

The longitudinal approach has the advantages of locating the pleural line in all circumstances.
Mastery of the LUS Blue Protocol (<3 min)

Normal lung

- Ribs
- Bat sign
- Pleural line
- Anterior lung surface
- “Sea and sand” sign
- Sector probe
1. Lung Ultrasound (LUS): The A lines

The A lines are horizontal artifactual repetitions of the pleural line displayed at regular intervals.
2. Lung UltraSound (LUS): Pleural Effusion

Quoad sign (2D LUS)

Sinusoid sign (M-mode)

A 15-mm distance is our minimum required for safe diagnostic or therapeutic puncture.
Pleural Effusion

Sector probe

PLAPS profile

35.8 mm

Sinusoid sign

M-mode
3. Lung UltraSound (LUS): Lung consolidation

The C profile

Massive consolidation of the whole lower lobe without aerated lung tissue and no fractal sign

Middle lobe consolidation not invading the whole lobe, with fractal border with aerated lung
4. Lung Ultrasound: Interstitial syndrome

Pulmonary Interstitial Edema is designed by diffuse lung rockets

Lung rockets are defined as at least 3 B lines between two ribs

LUS

Chest x-ray

B lines
Lung interstitial syndrome

B lines

Septal lung rockets correlating with edematous subpleural interlobular septa

Ground glass rockets correlating with ground-glass areas
Interstitial syndrome: Multiple B lines

Lung rockets

Glass rockets
5. Lung UltraSound (LUS): Pneumotorax

**The A’ profile**

- Abolished lung sliding "Stratosphere sign"
- Anterior abolished lung sliding + A lines
- Lung point at the area at the junction between dead air (pneumothax) and living air (inflating lung)
Pneumotorax

Sector probe

Lung point
LUS 10 signs

1. Bat sign (pleural line)
2. Lung sliding
3. A-line (horizontal artifact)
4. Quoad sign
5. Sinusoid sign
6. Fractal and Tissue-like sign
7. B-line (vertical artifact)
8. Lung rockets
9. Abolished lung sliding with Stratosphere sign
10. Lung point

Two more signs, the lung pulse and the dynamic air bronchogram, are used to distinguish atelectasias from pneumonia.
The association of A profile with venous thrombosis (venous scan) favours the diagnosis of pulmonary embolism

81% sensitivity

99% specificity
The BLUE Protocol Decision Tree

Performance of LUS in the critical care

Accuracy of LUS in the critical ill compared with Computed Tomography

<table>
<thead>
<tr>
<th>Ultrasound</th>
<th>Sensitivity</th>
<th>Specificity</th>
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</thead>
<tbody>
<tr>
<td>Pleural effusion [9]</td>
<td>94%</td>
<td>97%</td>
</tr>
<tr>
<td>Alveolar consolidation [10]</td>
<td>90%</td>
<td>98%</td>
</tr>
<tr>
<td>Interstitial syndrome [11]</td>
<td>93%</td>
<td>93%</td>
</tr>
<tr>
<td>Pneumothorax [12]</td>
<td>95%</td>
<td>94%</td>
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<tr>
<td>Complete pneumothorax [13]</td>
<td>100%</td>
<td>96%</td>
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<tr>
<td>Occult pneumothorax [14]</td>
<td>79%</td>
<td>100%</td>
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CT, computed tomography.

The BLUE Protocol combined with simple Echo

The BLUE Protocol applies LUS and venous ultrasound for drawing profiles.

A simplified echocardiography without Doppler can be associated with the BLUE protocol.

The BLUE protocol can be adapted to multiple clinical settings:
- Trauma
- Neonate
- Acute Respiratory Distress Syndrome (ARDS)
LUS can be used for answering two basic questions

1. Will the given patient benefit from fluid therapy?

2. If administered, when stop fluid?
FALLS protocol

Lichtenstein D, Heart Lung Vessels 2013;5:142-147
Lung UltraSound signs, either alone or combined to other point-of-care ultrasound techniques, are helpful in the diagnostic approach to patients with acute respiratory failure, circulatory shock or cardiac arrest.

Lung UltraSound is a useful diagnostic and monitoring tool that might become in the next future part of the basic knowledge of physicians taking care of the critically ill patient.

Lung ultrasound can be used for early detection and management of respiratory complications under mechanical ventilation, such as pneumothorax, ventilator-associated pneumonia, atelectasis and pleural effusions.