Ultrasound

In the critically ill respiratory failure patient

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Introduction

Overlooked?

BLUE protocol --> 18 years of research

Hard to explain due to urgency of situation

Allows you to give therapeutic options while organizing overall plan

Physical exam and radiography not precise
Introduction

BLUE protocol

Chest article showed 26% wrong dx in first 2 hours and inappropriate therapy

Observational study in teaching hospitals

Performed on admission, peak of dyspnea, serial on patients with respiratory failure

Final dx made by ICU team who did not take into account ultrasound data
Introduction - BLUE protocol

After years of lung terminology and analysis came up with three items:

1. Lung sliding present or absent

2. B lines at anterior wall present or absent

3. PLAPS present or absent (quad sign, shred sign, tissue sign, sinusoid sign)

Added adapted venous analysis (indicated in 54% of cases)
Principles of lung ultrasound

Upper and Lower BLUE points

Phrenic point

PLAPS point

Lichtenstein. Textbook. Whole body ultrasonography in the critically ill.
Principles of lung ultrasound
All signs arise from the pleural line

Pleural line
A1 line
Rib shadows
Principles of lung ultrasound

B line                          B7 lines                      B3 lines

Birolleau Variant

"Lung rockets"

Lichtenstein. Textbook. Whole body ultrasonography in the critically ill.
Principles of lung ultrasound

Lung signs are mainly based on analysis of artifacts

Lichtenstein. Textbook. Whole body ultrasonography in the critically ill.
Principles of lung ultrasound

Lung is a vital organ and most signs are dynamic

Lung sliding indicates inspiratory descent of the visceral pleura against the parietal pleura, and the expiratory ascent

Observation of the pleural line shows this to and fro dynamic (glittering, shimmering, sparkling, twinkling)

Better seen with longitudinal scans and hand must be motionless; M mode useful for data recording

*Seashore sign* and *stratosphere sign*
**Pleural effusion - Quad sign**

*More on deep border:* This line is called the lung line and is the visceral pleura; and visible when both pleura are separates by a structure that allows ultrasound transmission; the lung itself can be normal, show alveolar consolidation, or B lines.
Pleural effusion - sinusoid sign

**Sinusoid sign**: dynamic sign, respiratory variation of the interpleural distance

Also indicates low viscosity; very viscous or septate will not show Sinusoid sign
Tissue like sign

Shred sign

Lichtenstein. Textbook. Whole body ultrasonography in the critically ill.
Air bronchograms within tissue like sign
Punctiform and linear

Lichtenstein. Textbook. Whole body ultrasonography in the critically ill.
Lichtenstein. Textbook. Whole body ultrasonography in the critically ill.
BLUE profiles
hemodynamic pulmonary edema

**B profile** - anterior predominant B lines with lung sliding = pulmonary edema

**B line**: thickened interlobular septum --> then alveolar fluid

Pressurized transudate, includes all interlobular septa up to anterior wall against gravity = lung rockets

Transudates are supposed to not impair lung dynamics and explains preserved lung sliding

All or nothing rule when critical amount of fluid has thickened the interlobular septum

Staub. Physiology Rev. 1974
BLUE profiles
hemodynamic pulmonary edema

B profile - anterior predominant B lines with lung sliding = pulmonary edema

Anterior, lateral, posterior

Anterior = anterior Kerley lines, which are almost never visible on frontal radiographs

Lateral not incorporated due to simplicity

Posterior can be physiologic and leaky states (sepsis)

Distinction between hydrostatic and permeability induced pulmonary edema

Remy-Jardin. Imagre nouvelle de la pathologie thoracique quotidienne. 1995
BLUE profiles
Pulmonary embolism

A profile - bilateral A lines with lung sliding;
with PLAPS = pneumonia
with venous thrombosis = pulmonary embolism

None of the 92 pts with anterior interstitial patterns had pulmonary embolism; 20 of 122 with A lines only had pulmonary embolism
BLUE profiles
COPD and Asthma

Normal profile or Nude profile -
A profile without PLAPS = COPD or asthma

Bronchi surrounded by air are inaccessible to current non-invasive ultrasound

Absence of lung rockets in dyspneic pts
BLUE profiles
Pneumothorax

A’ profile -
A profile without lung sliding = pneumothorax
BLUE profiles
Pneumonia

A profile - bilateral A lines with lung sliding with PLAPS = pneumonia

B' profile - B profile without lung sliding = pneumonia

A/B profile - B lines on one side, A on other = pneumonia

C profile - anterior alveolar consolidations = pneumonia

This is because pneumonia are all different and can happen in different locations
**BLUE profiles**

**Pneumonia**

*B' profile* - B profile without lung sliding = *pneumonia*

Inflammatory adherences due to exudate, generating acute pleural symphysis, frequent in massive pneumonia and ARDS

Put another way: each exudative B line acts as a nail, each nail helps stick the lung to the wall
BLUE profiles
Pneumonia

A profile - bilateral A lines with lung sliding; with PLAPS = pneumonia

A/B profile - B lines on one side, A on other = pneumonia

C profile - anterior alveolar consolidations = pneumonia

This is because pneumonia are all different and can happen in different locations
This decision tree does not aim at providing the diagnosis. It indicates a way for reaching a 90.5% accuracy when using lung ultrasound.