ECOGRafia TOracaica e COVID19
IN TERAPIA INTENSIVA

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COVID-19 CRITICAL PATIENTS


• Italy → Up to 12% (Grasselli G et al Critical care utilization for the COVID-19 outbreak in Lombardy, Italy: early experience and forecast during an emergency response. JAMA 2020; published online March 13)

ICU admissions are dependent on the severity of illness and the ICU capacity of the Health-care system
COVID-19 CRITICAL PATIENTES

• Older and more comorbidities
• Common symptoms not specific: fever, cough, fatigue and dyspnoea
• Median time from symptom onset to severe hypoxaemia and ICU admission is 7 – 12 days (Yang X et al. *Lancet Respir Med* 2020; Arentz M et al. *JAMA* 2020).

ARDS (acute respiratory distress syndrome) → 60-70 %
Shock → 30%
Myocardial dysfunction → 20-30%
Acute kidney injury → 10-30%

Lancet Respir Med 2020; 8: 506–17

Critically ill patient with COVID-19

- Acute respiratory failure from ARDS
  - Oxygen supplementation to target pulse oximetry ≥ 90%
  - Intubation for worsening respiratory distress or failure, or multiorgan failure
- Moderate ARDS: $\text{PaO}_{2}/\text{FiO}_{2} \leq 200$ mm Hg
  - Provide moderate to higher positive end-expiratory pressure
- Severe ARDS: $\text{PaO}_{2}/\text{FiO}_{2} \leq 100$ mm Hg
  - Prone positioning; consider role of neuromuscular blockade and ECMO

Other intensive care management

- Low threshold for intubation if NIV or HFNC used for mild ARDS
- Most experienced operator with full PPE and minimised bag-mask ventilation
- Mild ARDS: $\text{PaO}_{2}/\text{FiO}_{2} \leq 300$ mm Hg
  - Limit tidal volumes ≤ 6 mL/kg predicted body weight and plateau pressure ≤ 30 cm H$_2$O

Blood cultures; consider empiric antibiotics and neuraminidase inhibitor initially

- Measure lactate; cautious fluids for hypovolaemia; check pre-load responsiveness; echocardiography; vasopressors or inotropes if needed

Avoid routine use of corticosteroids; avoid unnecessary patient transfers; use point-of-care tests such as ultrasound; consider repurposed and experimental therapies in a clinical trial

Renal replacement therapy if needed; protocolised light sedation; enteral nutrition and glycaemic control; early physical therapy; prevention of nosocomial infections; deep vein thrombosis prophylaxis; stress ulcer prophylaxis; liberation from mechanical ventilation
Why POCUS should be a priority in Covid?

- High sensitivity but low specificity.
- Fast at bedside and reproducible for monitoring disease course
- Cheaper test
- Easier to disinfect equipment compared to CT scan
- Easy in trained staff
- Avoid patientes transfer and ionising radiations

Box 1. List of Medline articles on POCUS in the COVID-19 pandemic, in chronological order

Peng et al.⁹
A letter to the editor describing their initial experience with POCUS in China. They were the first group to describe the ultrasound imaging features of COVID-19 and suggest it as an alternative to other imaging methods

Buonsenso et al.¹⁰
A case report of a young man with COVID-19 in Italy, describing acquisition technique and imaging findings

Soldati et al.¹¹
A letter asking the question “Is there a role for lung ultrasound during the COVID-19 pandemic?” The article covers the imaging features, acquisition technique, and practical advantages of using POCUS

Moro et al.¹²
In this article, the authors wrote a tutorial on how to perform lung ultrasound in pregnant women with suspected COVID-19, primarily targeted at an audience of gynaecologists

Soldati et al.¹³
Based on their clinical experience in Italy, Soldati et al. set out to propose an international standardised approach to POCUS in COVID-19. The authors describe a reproducible acquisition protocol and scoring system

Thomas et al.¹⁴
The first POCUS paper from North America during the COVID-19 pandemic. Thomas et al. describe the case of a 64-year-old woman with COVID-19, confirming the imaging findings of previous authors

Vetrugno et al.¹⁵
The authors reported their experience using lung ultrasound scoring in Italy

Kalafat et al.¹⁶
The authors report the case of a pregnant woman in Turkey admitted to ICU due to COVID-19. POCUS contributed to early clinical decisions in the ICU
Proposal for International Standardization of the Use of Lung Ultrasound for Patients With COVID-19

A Simple, Quantitative, Reproducible Method

Gino Soldati, MD, Andrea Smargiassi, MD, PhD, Riccardo Inchingolo, MD, Danilo Buonsenso, MD, Tiziano Perrone, MD, PhD, Domenica Federica Briganti, MD, Stefano Pelini, MD, PhD, Elena Torri, MD, Alberto Mariani, MD, Elisa Elenora Messori, MD, Francesco Tursi, MD, Federico Mentlo, MSc, Libertario Demi, PhD

LUS could be useful, being performed at several time points from clinical diagnosis, in determining early lung involvement during the paucisymptomatic phase of the disease and potentially playing a role in treatment decisions.
The pleural line is continuous and regular. Horizontal artifacts are present. These artifacts are generally referred to as A-lines.
B PATTERN
(Mild pulmonary disease/wet lung)

SCORE 1

The pleural line is indented. Below the indent, vertical areas of white are visible.
Score 2

The pleural line is broken. Below the breaking point, small-to-large consolidated areas (darker areas) appear with associated areas of white below the consolidated area (white lung).
The scanned area shows dense and largely extended white lung with or without larger consolidations.

Score 3

RESPONSABILI SCIENTIFICI:
G. Soldati, F. Tursi
CONSOLIDATION (Severe pulmonary disease)

Irregular pleura edges
Consolidation/Hepatization
Air bronchograms

Irregular PLEURA
Ø LUNG sliding
CONsolidation
HEPATIZATION
AIR BRONCHOGrams
A scan of the three different areas of the thorax: anterior, lateral, and posterior, and then superior and inferior segments are performed. Thus, six specific regions for each lung are defined and categorized by one of four different aeration patterns. A point scoring system is employed by region and ultrasound pattern as:

\[
A = 0 \text{ point, } B_1 = 1 \text{ point, } B_2 = 2 \text{ points, } C = 3 \text{ points.}
\]

\text{LUS of 0 is normal, and 36 would be the worst.}
COMMON FINDINGS

Right and left posterior inferior lungs involved in 75% of cases each.

Posterior superior 50%.
By informing the initiation, escalation, titration and weaning of respiratory support, lung ultrasound can be integrated into COVID-19 care pathways for patients with respiratory failure.
Point-of-care lung ultrasound in patients with COVID-19 – a narrative review

Table 2  A simplified description of where in the COVID-19 patient care pathway lung ultrasound is of most use.

<table>
<thead>
<tr>
<th>Severity of COVID-19–related lung injury</th>
<th>Typical sonographic characteristics</th>
<th>Typical clinical characteristics</th>
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<tbody>
<tr>
<td>Pre-disease to moderate</td>
<td>Development of B-lines which begin to increase in number and distribution. The pleural line begins to become irregular. Areas with B-lines are adjacent to normal areas of lung sliding and A-lines. These are ‘skip lesions’ or ‘spared areas’. Small (~1 cm) consolidations.</td>
<td>Respiratory rate &gt; 30 min⁻¹. Oxygen saturations ≤ 93% on room air. The need for supplemental oxygen. Lung tissue begins to lose aeration.</td>
</tr>
<tr>
<td>Severe</td>
<td>B-lines continue to increase in number and distribution, and begin to affect the upper and anterior areas of the lungs. B-lines become coalescent/confluent. Small consolidations increase in number and size.</td>
<td>Oxygen saturations ≤ 93% on supplementary oxygen. Clinical signs of respiratory distress. The need for additional supplemental oxygen or respiratory support. Lung tissue is becoming progressively de-aerated.</td>
</tr>
<tr>
<td>Critical</td>
<td>Extensive coalescent B-lines affect the upper and anterior areas of the lungs. Significant small consolidations affect the upper and anterior areas of the lungs. Posterior–basal sections of the lungs have significant bilateral alveolar–interstitial syndrome progressing to consolidation with or without air bronchograms. Pleural effusions are small or rare unless the patient’s fluid balance is high.</td>
<td>Likely to be or require invasive mechanical ventilation. The need for a high fraction of inspired oxygen. Dependent areas of lung tissue have becoming non-aerated.</td>
</tr>
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COVID-19 pneumonia: different respiratory treatments for different phenotypes?

Luciano Gattinoni¹, Davide Chiumello², Pietro Caironi³,⁴, Mattia Busana¹, Federica Romitti¹, Luca Brazzi⁵ and Luigi Camporotă⁶

Phenotype - L

Low elastance.

Low ventilation-to-perfusion (VA/Q) ratio.

Low lung recruitability.

Low lung weight.

Phenotype - H

High right-to-left shunt.

High lung recruitability.

High lung weight.

High elastance.
The first step to reverse hypoxemia is through an increase in FiO2 to which the Type L patient responds well, particularly if not yet breathless.

In Type L patients with dyspnea, several noninvasive options are available but continuous positive airway pressure (CPAP) should be preferred.

The magnitude of inspiratory pleural pressures swings may determine the transition from the Type L to the Type H phenotype. As esophageal pressure swings increase from 5 to 10 cmH2O—which are generally well tolerated—to above 15 cmH2O, the risk of lung injury increases and therefore intubation should be performed as soon as possible.
Once intubated and deeply sedated, the Type L patients, if hypercapnic, can be ventilated with volumes greater than 6 ml/kg (up to 8–9 ml/kg), as the high compliance results in tolerable strain without the risk of VILI.

Prone positioning should be used only as a rescue maneuver, as the lung conditions are “too good” for the prone position effectiveness, which is based on improved stress and strain redistribution.

The PEEP should be reduced to 8–10 cmH2O, given that the recruitability is low and the risk of hemodynamic failure increases at higher levels.

An early intubation may avert the transition to Type H phenotype.

Type H patients should be treated as severe ARDS, including higher PEEP, if compatible with hemodynamics, prone positioning and extracorporeal support.
Conclusions

POCUS has a high sensitivity for the pulmonary manifestations of COVID-19, such as ARDS and consolidation.

Furthermore, POCUS can be used to monitor treatment response. POCUS is an asset to hospitals as it minimizes nosocomial spread of the disease.

Application of LUS has allowed for identification of patients with lung involvement and severity. In addition, serial studies help us follow for progression or regression of disease.

With the application of LU we have had a noted reduction in use of chest x-rays and CT scans, helping us to make care and management of our patients a little more efficient.
Conclusions

Lung ultrasound is a simple bedside technique with numerous potential translational applications. It may help physicians in the diagnosis of the main respiratory disorders affecting the critically ill, thus suggesting the therapeutic approach in the emergency department and ICU.

Lung ultrasound can be employed to assess and monitor lung aeration in the acute respiratory failure patient and may be a useful tool to guide mechanical ventilation and several procedures, such as recruitment maneuvers, pronation, fiber-bronchoscopy and pleural drainage.

As a consequence, lung ultrasound has generated worldwide enthusiasm among physicians involved in the treatment of critically ill patients. Many clinical applications are nowadays suggested: the extent of their clinical impact and whether lung ultrasound should be part of the basic knowledge of all intensivists will be assessed in the next future.
Thanks