Management of critical COVID-19

Acute hypoxaemic respiratory failure and COVID-19: Recognize ARDS
Learning objectives

At the end of this module, you will be able to:

• Describe the etiology and pathophysiology of hypoxaemia with COVID-19.
• Describe an algorithmic approach to escalation of oxygen therapy from supplemental oxygen to advanced respiratory support interventions.
• Recognize and diagnosis ARDS.
Definition of acute respiratory failure

- Respiratory system unable to meet the oxygen and ventilatory requirements of the patient.
- Commonly requires advanced respiratory support interventions.
- Types of acute respiratory failure include:
  - upper airway failure
  - hypoxaemic respiratory failure $\text{SpO}_2 < 90 \ (\text{PaO}_2 \leq 50-60 \text{ mm Hg})$ despite supplemental oxygen therapy (10–15 L/min)
  - hypercapnic $\text{PaCO}_2 \geq 50 \text{ mm Hg}$ with pH < 7.35.
Before vaccination, studies found that nearly 5% of patients with symptomatic COVID-19 have critical disease.

- 70% of these patients have ARDS
- 25% with acute organ injury (acute kidney injury [AKI], cardiac, liver or sepsis).

Mortality in patients with critical illness has varied substantially in different cohorts throughout the pandemic.

Early in the pandemic mortality amongst critically ill was described at 50-60% or higher. Now, mortality is described around 30-40%. Mortality in resource-limited settings remains high.

Mortality is impacted by various factors, including access to oxygen, and safe high-quality critical care services, which include trained, multidisciplinary staff and protocols.
Example of data from patients admitted in African high-care or intensive care units (ACCOS)

• In a cohort of 3140 critically ill patients from 64 hospitals in 10 countries in Africa, in-hospital mortality within 30 days of hospital admission was 48.2%.

• Factors independently associated with mortality: age, HIV/AIDS, diabetes, chronic liver disease, chronic kidney disease, delay in admission due to a shortage of resources, quick sequential organ failure assessment score at admission, receipt of respiratory support or vasopressors.
Basics of oxygenation

INSERT VIDEO HERE
Causes of hypoxaemia

INSERT VIDEO HERE
Causes of ARDS, including COVID-19

INSERT VIDEO HERE
Intrapulmonary shunt

- Severe form of ventilation perfusion (V/Q) mismatch:
  - areas of lung perfused but not ventilated (V/Q < 1).

- Increasing FiO₂ does not readily improve hypoxaemia:
  - PEEP may recruit collapsed alveoli and improve shunt.
Clinical presentation of patients with ARDS

Rapid progression of severe respiratory distress:
• severe shortness of breath
• inability to complete full sentences
• tachypnoea
• use of accessory muscles of respiration
• cyanosis (very severe)
• persistent severe hypoxaemia
• refractory to supplemental oxygen therapy.
Definition of ARDS: adults

### Berlin definition

<table>
<thead>
<tr>
<th>Acute respiratory distress syndrome (ARDS)</th>
<th>Kigali modifications of Berlin definition</th>
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<tbody>
<tr>
<td><strong>Timing</strong></td>
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<tr>
<td><strong>Chest imaging</strong></td>
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<tr>
<td><strong>Origin of oedema</strong></td>
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<td><strong>Oxygenation</strong></td>
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<tr>
<td>Mild</td>
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<td>200 mm Hg &lt; PaO₂/FiO₂ ≤ 300 mm Hg with PEEP or CPAP ≥ 5 cm H₂O</td>
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<tr>
<td>Moderate</td>
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<tr>
<td>100 mm Hg &lt; PaO₂/FiO₂ ≤ 200 mm Hg with PEEP ≥ 5 cm H₂O</td>
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<tr>
<td>Severe</td>
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<tr>
<td>PaO₂/FiO₂ ≤ 100 mm Hg with PEEP ≥ 5 cm H₂O</td>
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**Challenge:** Arterial blood gas analysis less commonly used in children and in resource-limited settings; SpO₂ can be used instead.


Radiographic findings consistent with ARDS: bilateral opacities

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Definition of ARDS: paediatrics

| Age | Exclude patients with peri-natal related lung disease. |
| Timing | Within 7 days of known clinical insult. |
| Origin of oedema | Respiratory failure not fully explained by cardiac failure or fluid overload. |
| Chest imaging | New infiltrate(s) consistent with acute pulmonary parenchymal disease. |
| Oxygenation | Non-invasive mechanical ventilation PARDS (no severity stratification)  
Full face mask bi-level ventilation OR  
CPAP ≥ 5 cm H₂O  
PF ratio ≤ 300  
SF ratio ≤ 264  
Invasive mechanical ventilation  
Mild: 4 ≤ OI < 8 or 5 ≤ OSI < 7.5  
Moderate: 8 ≤ OI < 16 or 7.5 ≤ OSI < 12.3  
Severe: OI > 16 or OSI > 12.3 |

PF ratio: $\text{PaO}_2/\text{FiO}_2$ ratio. SF ratio: $\text{SpO}_2/\text{FiO}_2$ ratio.
OI: oxygenation index = $(\text{FiO}_2 \times \text{mean airway pressure} \times 100)/\text{PaO}_2$.
OSI: oxygen saturation index = $(\text{FiO}_2 \times \text{mean airway pressure} \times 100)/\text{SpO}_2$.

Challenge: Arterial blood gas analysis less commonly used in children; $\text{SpO}_2$ can be used instead.
Radiographic findings consistent with ARDS: bilateral opacities
WHO recommends prompt recognition of progressive acute hypoxaemic respiratory failure when a patient with respiratory distress is failing to respond to standard oxygen therapy and adequate preparation to provide advanced oxygen/ventilatory support.

Hypoxaemic respiratory failure in ARDS commonly results from intrapulmonary ventilation-perfusion mismatch or shunt and usually requires mechanical ventilation.

At any time, if there are urgent or emergent indications for intubation, do not delay.

We recommend prompt recognition of progressive acute hypoxaemic respiratory failure when a patient with respiratory distress is failing to respond to standard oxygen therapy and adequate preparation to provide advanced oxygen/ventilatory support.

WHO suggests that patients with severe or critical COVID-19 with acute hypoxaemic respiratory failure that do not require emergent intubation be treated with HFNO, or CPAP or NIV (BiPAP) over standard oxygen therapy.

WHO recommends in patients with critical COVID-19 that require intubation, implementation of mechanical ventilation using lower tidal volumes (4–8 mL/kg predicted body weight [PBW]) and lower inspiratory pressures (plateau pressure < 30 cm H₂O).

https://www.who.int/teams/health-care-readiness-clinical-unit/covid-19
If patient does not respond to escalating oxygen therapy, then consider advanced respiratory support interventions

**Emergency signs**
- Obstructed or inadequate breathing
- Central cyanosis
- Severe respiratory distress (i.e., significant tachypnoea, accessory muscle use)
- Signs of shock
- Seriously reduced level of consciousness
- SaO2
- Acidosis (pH < 7.30)
- Severe hypoxaemia, P/F < 100

**If patient does not respond to escalating oxygen therapy,** then consider advanced respiratory support interventions

**Consider intubation and mechanical ventilation**
Use lung protective ventilation

**Are Emergency signs present?**
- NO
- YES

Consider 1–2 hr trial of one of the following based on patient & local context:

- Is measurement correct?
- Is there a technical difficulty in delivering treatment?
- Is the patient getting appropriate therapy?
- Is there an alternate diagnosis?
- Is the treatment causing harm?

Choose best next intervention systematically:
- Does patient need urgent intubation and invasive ventilation?
- Is patient good candidate for non-invasive modalities?
- What advanced device is available to use?
- Is there a preference for a certain device over another? See Module 5 Part 1 for more details.
Reminder: always consider other causes of diffuse alveolar infiltrates

- Acute heart failure.
- Other acute pneumonias (not primary infection):
  - e.g. acute interstitial pneumonia, hypersensitivity pneumonitis, cryptogenic organizing pneumonia, eosinophilic pneumonia.
- Diffuse alveolar haemorrhage:
  - e.g. associated with autoimmune diseases.
- Malignancy:
  - e.g. bronchoalveolar cell carcinoma.
Key points

In patients with critical COVID-19, severe hypoxaemia related to ARDS is the leading cause of acute respiratory failure.

The most common pathophysioologic mechanism for hypoxaemic respiratory failure is ventilation/perfusion and, in its extreme, pulmonary shunt.

Thus, despite escalation of supplemental oxygen therapy, advanced respiratory support is crucial to deliver the accurate amount of oxygen at higher levels and with positive pressure ventilation.

Experience in using advanced respiratory support interventions is necessary to ensure safe and high-quality care is delivered to these patients.

WHO has conditional recommendations for the use of HFNO, CPAP and NIV for patients that have severe or critical COVID-19 and do not require emergent intubation.
Acknowledgements

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