

Oxygenation and Ventilation of COVID-19 Patients

Module 4: Ventilation Management

In collaboration with



American Society of
Anesthesiologists



American Association
for Respiratory Care

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To show skills clearly, the healthcare providers shown do not always use recommended personal protective equipment (such as gloves, masks, face shields).

GAP: Escalation to invasive ventilation

- **G: Gas exchange abnormality**

- COVID-19 respiratory failure is usually hypoxemic, not hypercarbic
- Worsening oxygenation: $\text{PaO}_2/\text{FiO}_2$ or $\text{SpO}_2/\text{FiO}_2 < 150$
- NIV with $\text{FiO}_2 > 0.6$ and can't maintain $\text{SpO}_2 > 90\%$
- Oxygenation unresponsive to HFNC therapy
- Hypercapnia with acidosis, $\text{pH} < 7.3$
- Increased work of breathing suggests deterioration of respiratory function

- **A: Airway protection**

- Altered mental status attributed to respiratory failure
- Neurological dysfunction

- **P: Pulmonary toilet**

- Increased airway secretions

Initial settings

- Ventilator settings: Lung protective ventilation
 - Initial mode of ventilation: Assist control PRVC
 - Tidal volume: 6 mL/kg PBW (calculate this from height and gender)
 - Male patients: $50 + 2.3 [\text{height (inches)} - 60]$
 - Female patients: $45.5 + 2.3 [\text{height (inches)} - 60]$
 - PEEP 10 cm H₂O: Monitor hemodynamics with increasing PEEP
 - Respiratory rate: 20-25
 - Consider patients' preintubation respiratory rate
- Goal: Limit overdistention of alveoli and ensure adequate oxygenation and ventilation. Overdistention causes inflammation, organ dysfunction, decreased venous return, and worsens ARDS.

Maintenance: Goals of therapy

Oxygenation

- PaO₂ >60 / SpO₂ 88-98%
- FIO₂ to maintain a SpO₂ of 88-98%
 - FIO₂ <0.6
 - Try to avoid 100% oxygen, which favors de-nitrogen atelectasis
 - Lower FIO₂ of 0.7-0.9 may not drastically change oxygenation due to high levels of shunt

Ventilation

- Tidal volumes of 4-8 mL/kg of PBW
- pH 7.25-7.42
- PaCO₂ 40-65 / end-tidal carbon dioxide (ETCO₂) 35-60 mm Hg

Pulmonary Mechanics

- Plateau pressures of ≤30 cm H₂O (reflects respiratory system compliance)
- Peak inspiratory pressure <35 cm H₂O

FIO ₂	0.3	0.4	0.4	0.5	0.5	0.6	0.7
PEEP	6	6	8	8	10	10	10
FIO ₂	0.7	0.7	0.8	0.9	0.9	0.9	1
PEEP	12	14	14	14	16	18	18-24

ARDSNet low PEEP/ FIO₂ Chart

Analgo-sedation

- A1 approach: Analgesia first, then add sedation
- Analgesia (fentanyl, hydromorphone, morphine):
Titrate to respiratory rate, Richmond-Agitation Scale (RASS), or pain score
- Sedation (propofol, benzodiazepine, dexmedetomidine):
Titrate to RASS
- Medications may need to be adjusted for ventilator synchrony
- All patients who received a neuromuscular blocker must also receive either propofol or a benzodiazepine for amnesia



When to troubleshoot

- Peak airway pressure greater than 35 cm H₂O
 - Evaluate the need for suctioning
 - Check plateau pressure
 - Check placement of ETT (deep?) and cuff pressure (do you hear a leak?)
 - Evaluate for pneumothorax: Chest x-ray, ultrasound
- Plateau pressure >30 cm H₂O
 - Requires an inspiratory hold maneuver
 - Reduce the tidal volume 1 mL/kg (minimum of 4 mL/kg)
 - Consider diuresis
 - Consider paralysis
 - Adjust respiratory rate lower (usually 2-6/min per change) to increase CO₂

When to troubleshoot (cont.)

- $FIO_2 > 0.6$ with $SpO_2 < 88\%$
 - Increase PEEP to level indicated on chart: Monitor blood pressure with each PEEP increase
 - Consider positioning of patient (ie, proning)
 - Consider diuresis
- $pH < 7.25$
 - Assess whether acidosis is respiratory or metabolic
 - Adjust respiratory rate higher (usually 2-6/min per change) to lower CO_2 (max 35/min)
 - If you go higher than a respiratory rate of 30, you will need to decrease the inspiratory time to 0.8 to avoid an inverse inspiratory-to-expiratory ratio
 - Monitor for auto-PEEP
 - Evaluate and treat metabolic abnormalities (check anion gap, lactate)
- $pH > 7.42$
 - Adjust respiratory rate lower (usually 2-6/min per change) to increase CO_2

Refractory hypoxemia

- Call for help early
- Consider proning to improve V/Q ratio mismatch
- Assess cardiac function (myocarditis and cardiomyopathy are reported)
- Consider nitric oxide to improve V/Q ratio mismatch
- Consider paralysis
 - Patient must be sedated with a benzodiazepine or propofol; analgesics do not provide amnesia for paralysis
- Consider extracorporeal membrane oxygenation (ECMO)

Call for help

- SpO₂ less than 88% on an FIO₂ of 1.0 for more than 15 minutes despite troubleshooting
- pH less than 7.25 for more than 2 blood gases
- pH less than 7.10
- PaO₂ less than 40
- SpO₂/FIO₂ or PaO₂/FIO₂ ratio of less than 150 for 2 hours
- SpO₂/FIO₂ or PaO₂/FIO₂ ratio of less than 80
- High-priority alarms (red) you cannot resolve within 2 minute
 - Manually ventilate until help arrives
- Low-priority alarms (yellow) you cannot resolve within 15 minutes

