Oxygenation and Ventilation of COVID-19 Patients

Module 4: Ventilation Management

In collaboration with

American Society of Anesthesiologists®

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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: PaO_2/FIO_2 or SpO_2/FiO_2 <150
  - NIV with FIO_2 >0.6 and can't maintain SpO_2 >90%
  - Oxygenation unresponsive to HFNC therapy
  - Hypercapnia with acidosis, 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

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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 [height (inches) – 60]
    - Female patients: 45.5 + 2.3 [height (inches) – 60]
    - PEEP 10 cm H_2O: 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

- PaO_2 >60 / SpO_2 88-98%
- FIO_2 to maintain a SpO_2 of 88-98%
  - FIO_2 <0.6
  - Try to avoid 100% oxygen, which favors de-nitrogen atelectasis
  - Lower FIO_2 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
- $PaCO_2$ 40-65 / end-tidal carbon dioxide ($ETCO_2$) 35-60 mm Hg

Pulmonary Mechanics

- Plateau pressures of ≤30 cm H_2O (reflects respiratory system compliance)
- Peak inspiratory pressure <35 cm H_2O

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/ FIO_2 Chart

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Analgosedation

- 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

SCCM Pain Agitation, Delirium Guidelines

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When to troubleshoot

- Peak airway pressure greater than 35 cm H_2O
  - 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 H_2O
  - 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 CO_2

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

- SpO_2 less than 88% on an FIO_2 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
- PaO_2 less than 40
- SpO_2/FIO_2 or PaO_2/FIO_2 ratio of less than 150 for 2 hours
- SpO_2/FIO_2 or PaO_2/FIO_2 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

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