Guidelines for management of ARDS and COVID

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1. Time course:
   - Anecdotal reports that progression of hypoxemic respiratory failure occurs rapidly (within ~12-24 hours)
   - From onset of symptoms, median time to:
     - Development of ARDS: 8-12 days (Wang et al., JAMA, 2020; Zhou et al., Lancet, 2020; Huang et al., Lancet, 2020)
     - Mechanical ventilation: 10.5-14.5 days (Huang et al., Lancet, 2020; Zhou et al., Lancet, 2020)

2. Management of Hypoxemia
   - Supplemental Oxygen:
     - Humidified nasal cannula (NC) 1 to 8 LPM for target SpO2 92-96%
     - If a patient requires > 8 LPM NC, initiate dry oxy mask (non-humidified to reduce aerosolization risk)
       - Start oxy mask at 9 LPM and FiO2 28%
       - Up-titrate FiO2 to goal SpO2 of 92-96% (not exceeding FiO2 35%)
       - If FiO2 > 35% then increase flow to 12 LPM
     - Change to HFNC at flow rate less than 30L
       - Recommend that the patient be off an aerosol generating device like HFNC or NIPPV for 45 minutes prior to intubation if clinically feasible
       - Use surgical mask over the high flow cannula
     - Early intubation:
       - Case reports from China suggest high failure rates for non-invasive ventilation, including high-flow nasal oxygen (Zuo et al., Chin Med Sci J, 2020)
       - For patients maintained on oxy mask, once FiO2=60% and SpO2 < 92%, call for intubation if patient is a candidate for mechanical ventilation
       - There is a COVID Airway Code Team with specific protocols for avoiding aerosolization.
       - Many centers suggest Rapid Sequence Intubation when fully paralyzed, without ambu-bag (which generates aerosols) and highly experienced operators (e.g., anesthesia/air way team).
       - Consider additional indications for intubation (tachypnea, work of breathing)

3. Initial Mechanical Ventilation
   - Intubations:
○ Should be attended by the Resource RT, who can facilitate early and appropriate ventilator settings with non-intensivists
○ Use “Mechanical Ventilation with Sedation” orderset (will attach separately)

- Initiate Volume Control (AC/VC) mode
  ○ Initial tidal volume (Vt):

- Vt = 6 ml/kg (based on ideal body weight [IBW] from ARDSnet table -see table)
  ○ IBW men (kg) = 50 + 2.3 (height in inches – 60)
  ○ IBW women (kg) = 45.5 + 2.3 (height in inches – 60)

- Initial respiratory rate 16-24, higher if acidosis present
- Initial PEEP based on BMI (available in Meditech in patients chart):
  ○ BMI < 35: PEEP 10
  ○ BMI 35 to 50: PEEP 12
  ○ BMI > 50: PEEP 15

- Initial FiO2:
  ○ 100% on intubation then rapidly wean to SpO2 92-96% (Barrot et al., N Engl J Med, 2020)

- Obtain STAT portable CXR to confirm endotracheal tube location:

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• CXR can wait if planning to place CVC/OGT etc

- Within 30 minutes of intubation, obtain an ABG (preferred) or a VBG and adjust ventilation and oxygenation as needed
- Initiate PEEP based on BMI
- If there are changes in clinical parameters, make changes in PEEP based on clinical parameters (hypoxia, elevated Ppl, etc) according to ARDSnet Lower PEEP table (below).
- Recommend the lower PEEP table as a back-up if PEEP cannot be individualized (e.g., experienced respiratory therapists or intensivists unavailable). The lower (rather than higher) PEEP table was selected primarily to avoid doing initial harm to patients with poor lung compliance.

### Lower PEEP/higher FiO2

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• After best PEEP determined, obtain respiratory mechanics:
  - Plateau pressure (with goal < 30, management below)
  - Static compliance
• Obtain arterial blood gas:
  - Goal pH 7.25 to 7.45
  - Calculate P/F ratio from initial post-intubation ABG

### 4. Targeting Sedation for Ventilator Synchrony

Initially target RASS -2 to -3 (see table):

• Maintain deep sedation immediately post-intubation while paralyzed (assume 60 minutes for Rocuronium, 10 minutes for succinylcholine)
• Preferred initial sedation regimen:
  - Fentanyl (boluses +/- infusion) + Propofol: target analgosedation and optimize analgesia first while decreasing sedative requirements
  - Measure triglycerides every third day on propofol or earlier if other reasons for hypertriglyceridemia
• Adjunct agent: Midazolam
• Use dexmedetomidine only when nearing extubation

Target ventilator synchrony: Ventilator-induced lung injury (VALI) is common in patients who are not synchronous with the ventilator and can cause significant lasting damage

• Once at target RASS after paralytics have worn off, assess patient synchrony with the ventilator (e.g. signs of breath-stacking, double triggering, other ventilator alarms)
  - Titrate sedatives/analgesics to ventilator synchrony allowing for deeper RASS
  - If patient remains dyssynchronous despite deep sedation (RASS -5), initiate continuous paralytics (ensure BIS 40 to 60 prior to initiating and during paralysis)
5. General Management of Ventilated ARDS Patients

- Consider whether patient requires daily CXR:
  - CXR clearly indicated for:
    - Clinical change
    - Concern for displaced ET tube
      - Sudden increase in peak inspiratory pressure or resistance
      - Decreased, unilateral breath sounds (usually on the right)
      - RN or RT concern for change in depth of ET tube at teeth
  - COVID-19 ICU Bundle:
    - Ventilated patients should all have a daily ICU “Bundle” of best practices. We would use our current ICU bundle as “COVID-19 ICU Bundle” [ICU BUNDLE COVID 19.docx]

6. Managing Ventilation

- Follow ARDSnet ventilation where possible:
  - Tidal volumes should be 4-6 cc/kg using IBW (see table above) to minimize volumes (and thus ventilator injury)
  - Minute ventilation (respiratory rate x tidal volume) typically drives pH and PC02:
    - Titrate ventilatory parameters to pH, not PCO2
To achieve low tidal volumes, we tolerate hypercapnia (functionally no limitation unless clinical sequelae) and acidemia (pH > 7.2).

Because tidal volumes are low, the respiratory rate often has to be high to accommodate; typical RR is 20-35 breaths/minute.

- **pH goal is normally 7.25-7.45:**
  - If pH > 7.45, decrease respiratory rate.
  - If pH 7.15-7.30, then increase respiratory rate until pH > 7.30, or PaCO2 < 25 (maximum RR= 35 breaths/minute).
  - If pH still < 7.15, then perform the following:
    - Tidal volume may be increased by 1 mL/kg until pH > 7.15 (until plateau pressure reaches 30 cm H2O or tidal volume reaches 8 cc/kg).
    - Deep sedation advancing to RASS -5 if needed.
    - If no improvement, initiate continuous paralysis.
    - If still no improvement, initiate prone ventilation (may improve V/Q matching and better ventilation).

### 7. Non-conventional ventilator strategies: APRV, HFOV, ECMO

#### APRV

- **Initial settings:**
  - Phigh set at 5cmH2O above plateau pressure/MAP (=/-5cmH2O); typically 25-35cmH2O.
  - Thigh set to maximize recruitment and augment ventilator clearance; typically, 3.0-5.0 sec.
  - Tlow set to achieve end Tlow when reaching 75% max expiratory flow rate (utilize flow graphic), typically 0.4-0.8 sec.
  - Plow set to 0.

- **Benefits:**
  - Recruits more slowly.
  - Raised mean airway pressure without increasing applied PEEP.
  - Additional spontaneous effort during inflation may enhance recruitment and cardiac filling.
  - More tolerable.

### 8. Managing Oxygenation

- **Minimizing oxygen toxicity:**
  - PEEP and FiO2 drive oxygenation.
  - The goal is to deliver a partial pressure of oxygen to perfuse tissues (PaO2 > 75, SpO2 >92%) while limiting lung injury from high distending pressures (Ppl < 30) and hyperoxia (FiO2 < 95, SpO2 < 96%).
  - Lower limit goals for PaO2 / SpO2 are widely debated; PaO2 > 65 and SpO2 >89% is commonly used.

- **PEEP management:**
  - Initial PEEP should be set as explained in section 4 above.
  - If patient is hypoxic on Vt = 6 ml/kg and ideal PEEP from PV tool (or PEEP determination from ARDSnet table), perform the following:
    - Deep sedation, advancing to RASS -5 if needed; if no improvement then:
    - Initiate continuous paralysis (cisatracurium bolus 0.2mg/kg followed by infusion at 0-5 mcg/kg/min titrated to patient-ventilator synchrony); if no improvement then:
- Initiate prone ventilation (see below); high consideration for use early in severe ARDS (<36 hours from ARDS onset, start discussion of proning when P:F < 150, prone within 12 hours of FiO2 > 75%)

- Checking plateau pressure:
  - Check plateau pressure with every change in tidal volume, PEEP, or clinical deterioration (worsening oxygenation) but not as part of routine practice
  - If plateau pressure is > 30 cm H2O, then decrease tidal volume by 1 ml/kg (minimum 4 mL/kg)
  - If plateau pressure is < 25 H2O and tidal volume < 6 mL/kg, then increase tidal volume by 1 mL/kg until plateau pressure is > 25 cm H2O or tidal volume = 6 mL/kg
  - If plateau pressure is < 30 cm H2O and patient is breath stacking or dys-synchronous, then increase tidal volume in mL/kg increments to 7 mL/kg or 8 mL/kg so long as plateau pressure is < 30 cm H2O

- Adjusting FiO2:
  - Adjust Fi02 after optimizing PEEP
  - Goal FiO2 < 75%; if FiO2 > 75%; patient requires ventilator optimization.
  - It is reasonable to put a desaturating patient temporarily on 100% FiO2, but remember to wean oxygen as rapidly as possible

9. Proning and Pulmonary Vasodilators

- Prone early:
  - Recommend early proning in severe ARDS without vasodilator trial (a departure from typical practice for ARDS not due to COVID-19 and lack of availability in CMC): < 36 hours from ARDS onset, start discussion of prone when P:F < 150, prone within 12 hours of FiO2 > 75% (Guérin, N Engl J Med, 2013).

- Eligibility criteria for proning:
  - Eligibility may vary depending on resources and staffing. Currently would recommend:
    - Age < 75
    - No high grade shock (either single agent norepinephrine 20 mcg/min or norepinephrine < 15 mcg/min and vasopressin)
    - Not on CRRT or at risk of impending renal failure (due to difficulties in maintaining dialysis access while prone)
    - The only absolute contraindications to prone ventilation are spinal cord injury and open chest; BMI and patient size are not contraindications

- Managing a prone patient:
  - Prone protocol attached
  - Maintain deep sedation with target RASS -4 to -5 while prone
  - 1 hour post-initiation of prone ventilation:
    - Adjust oxygen parameters: re-assess lung mechanics (plateau pressure and P-V tool to determine optimal PEEP) and adjust PEEP and titrate FiO2 as in “Managing Ventilation” (section 7)
    - Assess tidal volume and adjust ventilation parameters
      - If Vt < 6 ml/kg, may increase to maximum limit of 8 ml/kg while Ppl < 30
    - If patient demonstrates improvement on proning then recommend:
      - Discontinuing of continuous neuromuscular blockade and re-assess ventilator dyssynchrony; re-institute if dyssynchronous
      - Return to supine ventilation when following criteria are met:
        - Ppl < 25
➢ FiO2 < 50%
➢ pH > 7.3
➢ P:F > 200
○ Repositioning and skin care while prone:
  ▪ Continuing proning as per the proning protocol.
● Escalation if still hypoxic:
  1. If hypoxia (PaO2 < 55 with FiO2 > 75%) persists after proning, recommend consultation with hospital equipped with ECMO for transfer

10. ECMO consultation

● Refractory Hypoxemia:
  ○ If despite PEEP optimization, paralysis, prone ventilation, optimizing volume status, pulmonary vasodilators (when available) the patient meets the following criteria, then consider ECMO consult
    ■ Ppl > 30
    ■ FiO2 > 75%
    ■ P:F < 80

11. Management of secretions:

● ET suctioning as needed
● If thick secretions are of concern, recommend using 3% saline nebulization or mucomyst. Dornase alfa is a consideration.
● Avoid bronchoscopy if possible unless secretions could not be addressed by above methods, in negative pressure room with intensivist performing procedure only in the room with appropriate PPE.

12. Weaning from mechanical ventilation:

● Minimize sedation and fluid overload
● Assess need for continued intubation
● Palliative care to be involved in decision process
● Acute Weaning Phase Mechanical Ventilation
  ○ Screening:
    ■ Respiratory stability
      ➢ FiO2 50% or less
      ➢ Min Ventilation <12 LPM; >5LPM
      ➢ Peep generally less than or equal to 10
      ➢ Mean airway pressures <25
    ■ Hemodynamic stability, generally:
      ➢ HR >50 but less than <130, SBP >90 (or MAP >65) but less than 180 with little to no vasopressors. *abnormalities to these can be overridden by physician order.
    ■ Acute condition (ie reason for mechanical ventilation necessity) resolving
    ■ Bedside nurse concurs with weaning trial (may need sedation minimized etc)
    ■ No alternative order (ie physician preference against SBT trial)
● May initiate spontaneous breathing trial if requirements above are met and/or
  ○ Provider order for acute weaning phase ventilation verified
  ○ Physician/provider order present to utilize SBT, regardless of screening criteria
  ○ If not all criteria met above, but without clinical change in patients status with previous ability to undergo SBT
• Acute weaning of APRV
  ○ Adjust Tlow to facilitate end of Tlow when reaching 75% max expiratory flow rate (utilize ventilator graphics)
  ○ (Stretch) Adjust T high towards achieving goal of spontaneous minute ventilation equaling ½ of total minute ventilation (spontaneous minute ventilation can obtained from the 2nd tab of the monitoring screen)
  ○ (Drop) Adjust Phigh towards goal of <30cmH2O as soon as possible while maintaining TV goals, with an ultimate goal of <25cmH2O.
  ○ Plow remains at 0, but may vary based on compliance.

• SBT Trial
  ○ A SBT can be utilized at the respiratory therapist’s discretion once SBT requirements are met; commonly CPAP(PSV) trial
    ■ CPAP trial with Peep 5-10 and PSV 0-20, generally peep 5 PSV 5-10
    ■ RSBI may be evaluated within 30min to 2 hours
    ■ Patient comfortable with RSBI is considered passing if it is <105
    ■ Evaluation of airway capacitance (gag, cough, swallow reflexes) and sputum interference
    ■ Evaluate for notable cuff leak
  ○ If the patient passes the screening and trial, respiratory therapy can initiate extubation procedures with physician/provider’s approval and order. The therapist will then extubate the patient as per AARC clinical practice guidelines for extubation.AARC Clinical Practice Guideline—Removal of the Endotracheal Tube—2007 Revision & Update

Sources:

BWH Covid-19 Protocol


