**Pre-intubation Considerations**

- Awake patient prone has some anecdotal evidence. Initial recommendation for considered for escalating or worsening oxygen requirements, especially once on NIPPV (non-invasive positive ventilatory support) or high flow nasal cannula (HFNC) +15L/min.

**ARDS = Acute Respiratory Distress Syndrome**

- Diagnosis = acute hyperoxia with bilateral infiltrates on imaging of setting of >20 to FiO2 ratio <300 not fully explained by cardiac failure. Management focuses on oxygenating while reducing risks of ventilator-induced lung injury (VILI) by minimizing capillary shear, airway pressure, and FiO2 while using higher PEEP and deeper sedation or paralytics to maintain vent synchrony.

**Ventilator Basics – Goal to Oxygenate and Ventilate**

- Minute ventilation (MV) = Respiratory Rate per minute (RR) x Tidal Volume (TV)
  - This equation determines ventilation, and increasing MV will allow for more CO2 clearance. In general, we target low TV, which needs higher RR to maintain same MV.
  - Monitoring blood gases 15-30 minutes after ventilator change can aid in managing MV normal MV between 4-12 depending on clinical status.

**Oxygenation**

- Goal pulse ox >92%.
- Oxygen can be improved by increasing positive end expiratory pressure (PEEP) and FiO2 as needed. If using a high PEEP strategy, initially, with increasing PEEP and FiO2 and ARDS protocol, to obtain goal sat.
- However if ineffective, a subset of COVID patients appear to oxygenate better on a low FiO2 and high PEEP.

**Recruitment maneuvers** – Reef position patient on continuous pressure (often 30-40 cm H2O) for a set time (30-40 seconds) to recruit alveoli to improve oxygenation. It can be used to “refuel” when not meeting oxygenation goals and move to other methods such as paralysis, proning, inhaler therapy or ECLS consideration.

- Increased risk of arrhythmia or hypoxemia during maneuver.

**Ventilator Modes** – ARDS, control mode is recommended. In this condition, we generally avoid volume control, however volume control with inspiratory hold is appropriate in some cases.

- Pressure-limited assist control (PC) – Set the minimum RR, PEEP, and target inspiratory pressure (= pressure over PEEP, ΔP, or Δt) Decrease tidal volume in the presence of high PIP in order to meet MV goals.
- Vent will deliver set pressure and patient’s compliance will determine a dependent volume. Patient can breath faster than set RR if needed. Need to be monitored for changing volumes (such as increasing TV as compliance improves in ARDS) that would require change in delta.
- Pressure support (PS) – Set the FiO2, PEEP and ΔP, patient will determine their MV based on their compliance and RR.
- Best ventilator mode for lightly sedated patients requiring minimal support: improves synchrony and comfort, however requires more patient effort.

**Tidal Volume Goals** – If ARDS, target TV of 6 cc/kg (ideal body weight) (dependent on sex and height, not actual weight) (which is called low tidal volume ventilation (LTVV) with mortality benefit.

- Lung compliance determines how much pressure is required to reach a certain TV. Vent dysynchrony can maintain consistent TV difficulty, in which case would increase sedation and consider paralytics. Be careful to monitor plateau pressure (the pressure at end of inspiration that the patient puts on the ventilator) which should be <30 cmH2O or 20 cmH2O.
- Once plateau pressures >30, decrease TV by 1 ml/kg IBW down to 4 ml/kg IBW if needed.

- PEEP – this maintains pressure at alveolar level as patient exhales, which keeps recruited alveoli open. Require higher PEEPs, in some cases up to 20-24 cm H2O, to maintain oxygenation in ARDS, though some COVID patients appear to do better at low PEEPs (5-8). Minimum PEEP is 5 cm H2O.
- RR – Generally set at 12 to 16 breaths/minute initially unless significant hypoxemia. If not breathing spontaneously, repeat blood gases will aid in ensuring adequate MV (be sure to note actual TV and FiO2 and use calculation of 8-12 L/minute + 7.15 with hypoxia if at target TV in LTIV (common late in course for these patients), using RR to adjust MV. At RR >30, inspiratory times will begin to decrease and can decrease alveolar pressure or PEEP.
- I:E ratio – generally 1:3 but can move to 1:1 to maintain recruited alveoli.

**Sedation** – Often treating pain, delirium and agitation with multiple agents. Managed as step-up therapy, goal to have calm and responsive patient but similarly need to ensure enough sedation for ventilator synchrony and to limit double dysynchrony.

- If needed to increase sedation, use a very small dose of propofol (5-8 mcg/kg/min) or recommend to better assess for these possible outcomes.

**Changes in BOLD**

- COVID Specific Techniques
- Early high PEEP seems to beneficial in certain clinical phenotypes – would follow HIGH PEEP ARDSnet Table Initially (PEEP 14 to 18), however if patient develops worsening hypoxia and/or hemodynamics on those settings, then trial a low PEEP (8-12 cmH2O) with PEEP +FiO2, and high PEEP, depending on patient outcomes.
- Early threshold to paralyze and/or prone if not meeting oxygenation goals with moderate PEEP and moderate FiO2.
- Conservative fluid strategy – patients should be actively diuresed early on as blood pressure and creatinine tolerable if not adequately hypervolemic, regardless of clinical findings or ventilator settings.
- Currently recommending steroids in COVID-19 patients who are intubated, but only if they meet criteria for ARDS. Recommend methylprednisolone 1-2 mg/kg.
- Intubated patients with COVID-19 should have empiric antibiotics continued for full course treating baseline pulmonary superinfection.
- Do NOT use nebulizers, instead use metered dose inhalers (MDI) for albuterol.
- Do NOT extubate to aerosolized face mask, extubate to nasal cannula (NC), high flow nasal cannula (HFNC), or wide sealed NIPPV, (i.e. BIPAP) only, in general current plan is to extubate when you believe they can tolerate NC only.

**Ventilator Trouble-Shooting**

- Acute worsening hypercarbia or oxygenation on vent has broad differential for causes but a best evaluation of patient and ventilator parameters is very helpful. Remember that there can be multiple causes for issues at once.

- Check the plateau pressure (or peak pressure if in a rush).
- High peak pressures with normal plateaul pressure can be seen with ETT obstruction, mucus plugging (when laying flat (sit up patient), toxic drug effect (ex. Amiodarone), wheezing (increase bronchodilators), poor nutrition and weakness (ensure tube feeds, electrolyte replacement), and neuromuscular disease (myasthenia gravis, critical care myopathy, overedated).
- Generally recommend tracheostomy for patients on vent for 14 days or more, however need to consider long term potential for recovery and goals of care in COVID setting before tracheostomy, and current guidelines for tracheostomy in COVID-19 unclear.

**When to Consider Referral For Extra-corporal Life Support (ECLS)**

- Calling ECMO in 50% of patients who are intubated, but only if they meet criteria for ARDS (which is a difficult call and situation evolves fast rule for when to extubate.
- In general, with improved underlying pathophysiology with spontaneous breathing efforts (not on neuromuscular blocking agents and decreasing ventilator requirements should be considered for extracorporeal). With shocked patient P5 mode SBT between 30 to 120 minutes based on clinical scenario, without significant desaturations, tachypnea, or hemodynamic instability, and in COVID population, goal to extubate to <15 L HFCN, so should tolerate P5V with FiO2 <25.
- Generally SBT and Spontaneous Awakening Trials (SAT)
- These should be done daily and usually together, exceptions being those patients that are in severe ARDS, paralyzed, or require sedation for other purposes (like benzodiazepin for status epilepticus). SBT generally is P5 with delta of 5 and P5 of (“5 over 5”) and FiO2 <50 with sedation turned off or minimized. Obese patients may require 8/8.
- Other things to consider – Are there real situations manageable off vent? Is mental status improved enough to provide adequate airway once extubated? Do they have a sufficient cough? Can they generate significant inspiratory force without positive pressure (check by asking them to take deep breath)? Is the airway itself safe for extubation (i.e. angio, etc). Are they candidate for rescue therapy such as NIPPV or HFNC if they fail? Would patient want to be reintubated if fails extubation?

**Important Orders for Ventilated Patients – name of order in parentheses.**

- General Adult Ventilator Management – An order which sets I:E, positive end expiratory pressure, peak inspiratory pressure, and frequency. This order is used for patients who are intubated, but only if they meet criteria for ARDS.
- Ventilation Management – Input vent mode, FiO2, PEEP, and other required settings (such as TV, RR, SBT, RT frequency, etc). Recommend high PEEP (initially 8-12 cmH2O) when placing on ventilator or if improving vent synchrony. Often improve oxygenation and rate ventilation, and can consider pulmonary emboli or an extra-vascular process.
- Adult Continuous Sedation & Paralytics – “order panel for sedation and paralytics
- “Extracorporeal” – would discuss with RT timing of extubation and plan for post-intubation oxygen support.
- “Sedation protocols” – Initially in ventilator roadway
- “Keep prone” – A nursing order for prone patients, there is a “specialty bed (aka PRONE POSITION) order but we do not have extra prone beds at this time.

**Inhaled Pulmonary Vasodilators** – Currently only inhaled epoprostenol recommended for COVID population to relieve vaso resistance. Started at 30-25 mcg/kg/min, increased stepwise based on efficacy and tolerability up to 50 ng/kg/min. Wean by decreasing by 10 ng/kg/min every 1-2 hours.

**Lifepath COVID-19 Vent Tip Sheet**

- **Helpful Links**
  - **Lifepath COVID-19 Provider Information**
  - **Airway Management Algorithm**
  - **Neuromuscular Blockade Assessment for COVID**
  - **ARDSnet Protocol**

**Oxygenation**

- **Therapeutic Management**

This document was created by the Division of Pulmonary, CriticalCare, and Sleep Medicine at Brown University and may be modified or updated by COVID-19 situation evolves.