



COVID-19 Vent Tip Sheet

Version 3
Updated 4/16/2020
Changes in **BOLD**



Pre-intubation Considerations

- Awake patient proning has some anecdotal evidence. Early intubation recommended for clinical worsening or escalating oxygen requirements, especially once on NIPPV (non-invasive positive pressure ventilation) or high flow nasal cannula (HFNC) > 15 L/min.

ARDS = Acute Respiratory Distress Syndrome

- Diagnosis = acute hypoxia with bilateral infiltrates on imaging in setting of pO_2 to FiO_2 ratio <300 not fully explained by cardiac failure. Management focuses on oxygenating while reducing risks of ventilator induced lung injury (VILI) by minimizing tidal volumes, airway pressure, and FiO_2 while using higher PEEP and deeper sedation or paralytics to maintain vent synchrony.

Ventilator Basics – Goal is to Oxygenate and Ventilate

- Minute ventilation (MVE)** = Respiratory Rate per minute (RR) x Tidal volume (TV)

- This equation determines ventilation, and increasing MVE will allow for more pCO_2 clearance. In general, we target low TV, which require higher RR to maintain same MVE.
- Monitoring blood gases 15-30 minutes after ventilator change can aid in management. Normal MVE between 4-12 depending on clinical status.

Oxygenation

- Goal pulse ox >92%.
- Oxygenation can be improved by increasing positive end expiratory pressure (PEEP) and FiO_2 as needed. In setting of ARDS, would favor using a HIGH PEEP strategy initially, with increasing PEEP and FiO_2 per ARDSnet protocol to obtain goal sat. However if ineffective, a subsets of COVID patients appear to oxygenate better on a low PEEP/high FiO_2 setting.**
- Recruitment maneuvers** – RT places patient on continuous pressure (often 30-40 cm H₂O) for a set time (30-40 seconds) to recruit alveoli to improve oxygenation. Can be used as “rescue” when not meeting oxygenation goals but if repeating then should move to other methods such as paralysis, proning, inhaled therapy or ECLS consideration. Increased risk of arrhythmia or hypotension during maneuver.

- Ventilator Modes** – In ARDS, control mode is recommended. In this institution, we generally avoid volume modes, 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, AP, or “delta”).
 - 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 FiO_2 , PEEP and AP, patient will determine their MVE 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 of **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 make consistent TV difficult, in which case would increase sedation and consider paralytics. Be careful to monitor plateau pressure (the pressure at end inspiration without flow), which should be < 30 cm H₂O and often limits our TV and MVE.
- 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 hypercarbia. If not breathing spontaneously, repeat blood gases will aid in ensuring adequate MVE (be sure to note actual TV and RR when calculating MVE, versus set RR). **We tolerate pH >7.1-7.15 with hypercarbia if at target TV in LTVV (common late in course for these patients), using RR to adjust MVE.** At RR >30, inspiratory times will begin to decrease and can cause recruitment or patient auto-PEEPs.
 - 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 vent synchrony and to limit double-triggering (breath stacking). There is some evidence at patient who are breathing spontaneously with increase work of breathing (such as abdominal breathing, significant tachypnea, accessory muscle use, etc.) might be causing further lung injury, so would recommend increasing sedation in these patients.

- Assess pain first – fentanyl PRN (50 to 200 mcg per dose) mainstay. May cause hypotension. Avoid infusion when possible. Consider longer acting agents, **enteral formulations**, or higher dosing if on chronic opiates and poor control.
- Agitation – favor propofol (5-80 mcg/kg/min) or precedex (0.2-1.5 mcg/kg/hr) infusions as first line for their short half lives. They do not treat pain. Propofol can cause hypotension and pancreatitis (**need 1st and 3rd day lipase/TGs monitored, if >180 or >1000 respectively then must be stopped**). Precedex can cause bradycardia and/or hypotension and may not sedate some patients. Benzodiazepines are not generally recommended unless there is another indication such as seizure or alcohol withdrawal.
- If require further sedation despite these medications and/or hospital is rationing sedatives/analgesics, please consult pharmacy for most up-to-date sedation protocols**
- ARDS patients on vent requiring paralytics MUST be on fentanyl infusion (100-300 mcg/hr) and versed infusion (6-12mg/hr) while paralyzed, for deep sedation.

- Proning** – Consider if FiO_2 >0.6 to maintain sats >92%. Patient is placed prone (face down) in order to improve ventilation and perfusion (VQ) matching and potentially improve alveolar recruitment. Improves mortality in ARDS. Generally prone for 12-16 hours. Need to consider access and body habitus prior to proning, as well as **contraindications**. Often improve oxygenation within minutes to hours, if not reaching goals once prone for 6-8 hours then need to consider ECLS. **Video example.**

- Neuromuscular Blockade (NMB)** – Used to facilitate LTVV, especially in setting of dysynchrony, proning, or high plateau pressures. Currently recommend trial intermittent bolus (generally use atracurium here), but then switch to continuous infusion if persistent need for NMB. In general once on continuous infusion, wait 12 to 24 hours before determining if ok to wean back. Goal <48 consecutive hours paralyzed. Need “train-of-4” monitored by RN which tests muscle contractions post-stimulus, with goal TOF count 1. Patient must be deeply sedated with fentanyl and versed infusions before paralytics.

- Inhaled Pulmonary Vasodilators** – Currently only inhaled epoprostenol recommended for COVID population to improve VQ matching. Started at 10-25 ng/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.

COVID Specific Techniques

- Early high PEEP seems to be 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 strategy (5-8) with higher FiO_2 allowed to obtain goal oxygen saturations**
- Early threshold to paralyze and/or prone if not meeting oxygenation goals with moderate PEEP and moderate FiO_2 .
- Conservative fluid strategy – patients should be actively diuresed early on as blood pressure and creatinine tolerate if not actively hypovolemic, regardless of classical findings for volume overload
- 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 bacterial pneumonia 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 well 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 bedside evaluation of patient and vent 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 plateau pressure can be seen with ETT obstruction, mucus plugging from secretions, or bronchospasm. If plateau pressure also increased, consider abdominal distension, asynchronous breathing, partial or total lung collapse, auto-PEEPing (not enough time to exhale completely), pneumothorax, or significant pulmonary edema.
 - If peak pressures are significantly low, consider an air leak in line. If there is no change in peak pressures, consider pulmonary emboli or an extra-thoracic process
- A repeat CXR, blood gas, and evaluation by RT for ventilator issues (they can help clear secretions and deep suction, ensure better vent synchrony, and increase vent support as needed) are recommended to better assess for these possible outcomes.

Reasons for Failure to Wean from Vent (and Their Treatments)

- Majority of COVID-19 population appears to wean very slowly over course of weeks**
- Common causes are fluid overload (diurese), airway resistance (ETT too small for spontaneous breath trial (SBT)), new pneumonia (work-up and treat), worse VQ matching when laying flat (sit up patient), toxic drug effect (ex. Amiodarone), wheezing (increase bronchodilators), poor nutrition and weakness (ensure tube feeds, electrolyte repletion), and neuromuscular disease (myasthenia gravis, critical care myopathy, oversedation).
- 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-corporeal Life Support (ECLS)

- Currently can provide ECMO (extracorporeal O₂ and potentially hemodynamic support) and ECCOR (extracorporeal CO₂ removal), though limited circuits available. Consult the MICU attending if would like patient considered, data shows early consideration (within 7 days of ARDS) better for outcomes.

When To Consider Extubation

- There is no hard-and-fast rule for when to extubate.
- In general, patient with improved underlying pathophysiology with spontaneous breathing efforts (not on neuromuscular blocking agents) and decreasing vent requirements should be considered for extubation. Generally should tolerate PS mode with SBT for between 30 to 120 minutes depending on clinical scenario, without significant desaturations, tachypnea, or hemodynamic instability, and in COVID population, goal to extubate to <15 L HFNC, so should tolerate PSV 5/5 with $FiO_2 \leq 25\%$.
- Daily 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 benzo gtt for status epilepticus). SBT generally is PS with delta of 5 and PEEP of 5 (“5 over 5”) and $FiO_2 \leq 50\%$ with sedation turned off or minimized. Obese patients may require 8/8.

- Other things to consider – Are tracheal secretions manageable off vent? Is mental status improved enough to protect 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. angioedema, 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 set which includes NPO, continuous pulse oximetry, telemetry monitoring, maintain head of bed >30 degrees, oral care, adult respiratory care protocol (used for RT to follow as consult), as well as labs, imaging, and stress ulcer prophylaxis order set. Use this for every patient newly intubated.
- “Ventilator Management” – Input vent mode, FiO_2 , PEEP, and other required settings (such as TV, RR, delta). RT will frequently change this order as needed. Would ensure direct communication with RT if making an important vent change. This order is called “Mechanical ventilation” when part of order set.
- “ICU MICU Analgesia-Based Sedation & Delirium Protocol” – An order set, which include the CAM-ICU, CPOT, and RASS assessments, non-pharm delirium interventions, and medication options for analgesia (fentanyl pushes) and agitation (precedex and propofol w appropriate labs), as well as delirium medications which we general do not use up front.
- “Adult Continuous Sedation & Paralysis” – order panel for sedation and paralytics
- “Extubation” – Would discuss with RT timing of extubation and plan for post-intubation oxygen support.
- “Epoprostenol (VELETRI) inhalation solution” – Inhaled pulmonary vasodilator
- “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.

Helpful Links

- [Lifespan COVID-19 Provider Information](#)
- [Airway Management Algorithm](#)
- [Lifespan Algorithm to Assess for COVID](#)
- [ARDSnet Protocol](#)
- [Surviving Sepsis Campaign COVID-19 Guidelines](#)
- [Oxygenation](#)
- [Therapeutic Management](#)