

## COVID ICU Management

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### Ventilator Basics

- Overall, preference towards volume control, as most MDs and RNs are familiar with its alarm settings and can troubleshoot accordingly. If you're going to do pressure control, that's fine, but make sure you set the alarms yourself as it will default to numbers that are often inappropriate for our patients.
- On the Servo-i vents, you can adjust your I-time, inspiratory rise, and add a pause to effectively do inverse ratio ventilation without switching to pressure control, so really no benefit to switching to pressure control unless for patient comfort if they are more awake/improving ARDS.
- When first putting them on the vent after intubation, usually start tidal volumes at 7-8cc/kg then over the next few hours walk them down to 4-6cc/kg per ARDSnet trial (low tidal volume).
- Make sure during rounds that you always mention the patients peak and plateau pressures over the last 24h and if they've changed significantly from day before. If they are on pressure control, you'll be reporting tidal volumes instead.
- Expect very poor compliance and high peak pressures over 30. May not always be feasible to decrease peak pressures to less than 35 without compromising your tidal volumes, so we end up being a little lenient and letting peak pressures ride higher up to 40, but would discuss with attending what the peak pressure goal is for each patient.
- Have found that higher PEEP (greater than 14-16) has not been very effective in improving oxygenation, so would strongly recommend discussing with attending first if you want to use a higher PEEP than 16. Not a very PEEP responsive disease beyond those numbers, but there may be exceptions for each patient.
- Every day make note of where the ETT should be, make sure it's written on the whiteboard or head of bed in each patient room. Very frequently the tube will move during proning/supination, so always review ETT placement on daily CXRs and at bedside.
- General approach to try to improve oxygenation after pt is on optimal vent settings has been to first use inhaled epoprostenol/iNO, then paralytics if refractory, then proning.
  - On rounds, make sure to note the start and end dates for all of the above interventions (on paralytics since \*\*\*, s/p intermittent proning, has remained supinated since \*\*\*, etc.)
- Using the study design from PROSEVA trial, we typically do 16 hours prone overnight, then 8 hours supine during the day. Usually flipping rounds at 7-9am and then again from 3-5pm. For patients to be supinated in the AM, goal is to have P/F ratio >150. For patients to stay supine in the PM, need to have FiO<sub>2</sub> ~60%, otherwise they are prone again.
- General approach to weaning a COVID patient from the ventilator has been to first make sure they've stayed supine for ~48h, then weaning off paralytics, then inhaled pulmonary vasodilators, and then finally weaning the PEEP. Sometimes weaning of the PEEP and vasodilators are done simultaneously, usually per attending choice.

- As patients' compliance improves and sedation is weaned, then we switch to pressure control and allow for more patient comfort, but make sure alarms have been tightly set to avoid any sudden drops or increases in minute ventilation.
- Troubleshooting the vent:
  - High peak pressures --> go to bedside, check your peaks and plateaus. Need to consider pneumothorax immediately if high plateau and not getting adequate tidal volumes. Also consider obstruction (mucus plugging, bronchospasm) if plateaus are low. But may just be worsening compliance from COVID. Consider decreasing tidal volume to 4cc/kg if the patients' pH allows, could also consider decreasing PEEP as oxygenation allows as higher PEEP may be worsening dead space.
  - Worsening oxygenation --> could just be worsening ARDS, see above for starting pulm vasodilators/paralytics/proning, but also consider PE (especially if associated w/ worsening hypercapnia), new VAP (new consolidation on CXR? Fever? Increasing WBC?). See above if also associated with high peak pressures.
    - Patients may need to be bagged at some point to help bring their SpO2 up but remember that you're giving much larger tidal volumes via BVM so watch carefully for barotrauma after bagging
  - Worsening hypercapnia --> likely worsening dead space from COVID (significant impact on pulmonary vasculature). Permissive respiratory acidosis in patients, can let it ride ~7.25, but in patients who've had COVID for a long time, you could see pCO2s in 80s/90s, even >112 (upper limit of detection). See what you can do to improve ventilation, likely not much room for tidal volume but increase the rate as tolerated (but make sure not air trapping/auto-PEEPing). Consider adjusting I-time/adding a pause for more inverse ratio ventilation and allow more diffusion of CO2. Potentially higher PEEPs can worsen dead space so could also try decreasing PEEP but would discuss with attending. Important to consider other causes of hypercapnia (PE, sepsis/fever, steroids, hyperthyroid, electrolytes, etc.). If very severe, can discuss with Nephrology about ECCO2R (extracorporeal CO2 removal).
- In general, expect very slow changes to the vent. There may be some days where you feel like you're not doing much at all. Attendings generally like to do one big change per day because the patients are so tenuous.

## COVID Complications

- Positioning
  - Many patients will end up prone for extended periods of time so it's important to think about what studies and/or procedures need to be done when they're face up
  - Prone lines can be done (by attendings) but are very difficult so try to get all lines in before patients are proned
  - DVT US and echos should be timed when they are face up
  - Patients can often have hemodynamic compromise around proning/supination. Come prepared with a plan if things get worse. Remember that compressions are not as effective when done on a prone patient. So need to decide if you'll code patient while proned or if there's time to supinate quickly. Good idea to have atropine or epinephrine at bedside, get them an O2 breath, run blood pressures a little higher, etc.

- Don't expect immediate changes to their SpO<sub>2</sub>. COVID patients take a very long time to recover from any small repositioning due to suspected impairment in autoregulation of hypoxic vasoconstriction. It may feel like a lifetime for their SpO<sub>2</sub> to bump back up but give some time before making any changes
- Hypercoagulability
  - Generally low threshold to start empiric anticoagulation but we've been trying to find actual data that prompts us to start therapeutic lovenox or heparin since there have been a fair number of spontaneous RP bleeds.
  - Try to do 4 extremity ultrasounds on new admits before they are prone to assess for clot burden
  - Can look for significant increase in d-dimer to prompt starting AC
  - Attempt to get CTA chest on admission as renal function allows (usually done in ED but may not always be ordered)
  - If worsening oxygenation despite inhaled vasodilators/paralytics/proning/abx, etc, would consider starting empiric AC
  - Make sure everyone is on at least DVT prophylaxis
- Shock
  - Differentials to consider
    - Septic --> either from COVID itself or new superimposed infection. Consider VAP, bacteremia (make note of what lines the patient has and if they need to be replaced), UTI, etc.
    - Hemorrhagic --> often on therapeutic AC so check for RP bleed, GI bleed
    - Obstructive --> Tension pneumothorax? Look at vent (high peak pressures), examine (absent lung sounds), bedside US (absent sliding sign), CXR. PE? Do bedside echo, look for RV dilation, septal bowing. We have pushed tPA in a few patients. Can also consider tamponade but haven't seen this frequently.
    - Cardiogenic --> COVID myocarditis, Takotsubo, STEMI/NSTEMI, HFrEF; a few patients have needed inotropes; check an echo/EKG when supine, watch troponins, NT-proBNP, etc.
    - Refractory shock: check cortisol, acid/base status, ionized calcium
- Infections
  - Typically VAPs or bacteremia
  - A lot of antibiotic resistance because patients have been in-house for a long time. Make sure to use antibiotics appropriately. Look for a clinical change to prompt initiation rather than just an increasing WBC (New consolidation? Increasing pressures? Febrile?).
  - Patients may need stress dose steroids but also increases their risk of new infections. Keep tabs on the dose and your strategy for weaning as appropriate.
  - Make sure to note the duration of your lines during daily rounds and exchange them when needed
- Renal failure/fluid status
  - Many patients progress to renal failure, we'll do our best to prevent this but may not always be possible
  - Patients who first come into the hospital are typically volume down. They've been febrile, poor PO intake, maybe having vomiting/diarrhea, and usually needs fluids when

they come in. Think carefully about diuresing them right away. Dry lungs are happy lungs but we can easily diurese in the future. But once they progress to renal failure, it's typically a poor prognostic sign.

- You can look at their arterial line (if vented) for signs of fluid responsiveness. If you notice respiratory variation in the amplitude of the arterial line tracing, this could mean that they're volume down, but can also be seen in obstructive shock.
- When patients do require CRRT, would have a discussion first with attending on whether it will be offered to patient based on their prognosis. Palliative Care can help with broaching these discussions.
- Sedation
  - COVID patients usually require deep sedation as they are often paralyzed
  - Can start with fentanyl/propofol but because of the duration of intubation and associated shock, propofol is not always well tolerated, so often switch to versed.
  - If patients develop tachyphylaxis from fentanyl, can then switch to dilaudid.
  - A few patients have been very difficult to sedate, requiring ketamine and/or precedex; Palliative Care has been very helpful in guiding sedation choices
  - Expect withdrawal as weaning sedation. Consider scheduling valium, haldol, oxycodone, etc (with discussion w/ Palliative Care) to help with weaning.

#### Rounds

- One-liner: include age, sex, pertinent medical history, day of hospital admission, day of intubation, any pertinent hospital complications
- Overnight events
- Vitals
- Vent: include the peaks/plateaus (if VC) or tidal volumes (if PC), inhaled pulm vasodilators, paralytics, and proning; a lot of attendings like the ABG here too and if you adjusted vent from that ABG. Make sure to include I/Os. If they have chest tubes, note if there is an air leak, how much output there is, etc. Note where the ETT tube is, and what their 4-6cc/kg tidal volume goal is (may not present it but have it on hand in case attending asks)
- Drips: sedation, pressors, AC, antibiotics
- Exam: keep it simple, only new pertinent findings
- Lines: note how long they've been in
- Labs: pertinent only
- Imaging
- A&P