Discussion points: clinical management of COVID-19
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1) **clinical trajectory**: onset and resolution

    - Patients deteriorate incredibly fast; stable patients go from room air to 6L to needing intubation within hours; it's not at all predictable which stable patients will need the ICU in 12 hours; we are following inflammatory indices (ferritin, c-reactive protein, d-dimer, etc.) which seem to spike before deterioration but haven't been validated.
    - I was pretty accommodating re bringing floor patients to the RICU, and without fail they all needed the ICU; I had no "false positives" re unit transfers; these are not patients that you can say "let's see how they do over the next few hours and bring them to the unit if needed."
    - Hypoxemia on the vent is persistent, waxes and wanes; makes prognostication and family communication very challenging; in the first Wuhan series, mortality among ventilated patients was 31/32; in the Netherlands registry, projected median duration of ventilation is 14-20 days; I was frustrated by inability to suggest time-limited trials; instead of "let's see how she/he does in the next 48 hours" I'm saying "let's see how she/he does in the next two weeks."
    - The waxing and waning nature of the prolonged course confounds extubation planning (below); I don't think the high re-intubation rate is due to anything other than this prolonged and irregular trajectory of resolution; I hate to think that we have to keep these patients on vents for multiple days of passed SBTs.
    - It's not hopeless. I didn't personally extubate anyone in the RICU, but there have been several who have been successfully extubated in the RICU and at the VA.

2) **management of hypoxemia**: **pre-intubation** (HHFNC, NIV, threshold for ETT, practical considerations regarding intubation)

    - It is *not* the case that HHFNC is futile; we definitely had some patients who avoided an ETT because of HHFNC (they were rare); favorable trajectory was nasal cannula → HHFNC 40%-50% for several days then de-escalation; this worked in a few patients.
    - *BUT* if the HHFNC is up to 60% or 70%... I didn't bring any of those patients back from the brink. They all got an ETT eventually. And these intubations are scary, with precipitous desaturations and constraints on preoxygenation, etc.. I grew more and more chicken as the week wore on. For me now, persistent FiO2 requirements greater than 50% on HHFNC is indication for controlled intubation. Otherwise I'm pretty sure you're delaying the inevitable and making it less safe for the patient and

providers. I really wish we has better clinical data on thresholds for intubation.

- These patients really don't look dyspneic. They aren't hypercapnic and the hypoxemic respiratory drive just isn't triggered. It's like pneumocystis in this way. So I almost never intubated someone for perceived work of breathing. It was always for inability to keep SaO2 above 88-90 despite high FiO2. Again, I'd love an RCT of intubation thresholds. Most aren't that tachycardic, either. It's weird.
- Re NIV: there is a strong reluctance to use it, but I think there may be a role. If we use a vent (rather than a typical BiPAP machine) and the seal is good, we can achieve a closed circuit and its as safe as HHFNC. These patients are really PEEP-responsive. They need 100% via HHFNC, then the ETT goes in, and they only need 40% with 12-14 PEEP. It's really the positive pressure they need. Worth considering whether we're being too restrictive with NPPV. Consider trying CPAP with a good seal.
- Call Anesthesia as soon as you think it's likely you're going to tube the patient. It takes them a minimum of 10 min to get to the RICU (they don their PPE remotely). The longest was >30 minutes. Then they (understandably) systematically run through their plan in the hallway. If you wait until the patient's on 100% HHFNC and failing, it'll be ugly.
- Pre-intubation rescue measures: I proned an awake, non-intubated patient (asked her to roll on her stomach) and it definitely improved her SaO2, and persistently so. Part of me worries that their lung injury will continue to worsen despite this and when we need to roll them over to intubate them they'll be even less stable. But it's an option. Would love to try iNO or other therapies to see if we can ward off intubation in some but at the moment I don't think that's an option.

3) **management of hypoxemia**: **post-intubation** (PEEP, NMB, proning, iNO, ECMO, etc.)

- In my experience these patients don't have the profound hypoxemia of (e.g.) H1N1 patients. Once the tube is in they typically only need 40-60% FiO2 and relatively high PEEP (12-16). A few progressed and were seriously considered for ECMO, but most just ride the vent at moderate settings for ages.
- I saw a lot of vent dysynchrony and thus was quick to use paralytics as my first escalation, followed by proning. But my own practice was variable here. Others prone first. The Anesthesia/SCC side was using more iNO. We really need a good registry with local and national practice variation with outcomes to be more informed about this (Admon's working on this now).
- I used the high-PEEP ladder. It was easy to get them down to 40% FiO2 but hard to get them below 12 of PEEP. I grew more accommodating re starting SBTs (though more conservative regarding what I considered a "passed SBT").

4) **vent liberation** (SBT strategy, threshold for extubation, post-extubation support)

- Re-intubation rates are high, both globally in our limited local experience. Re-intubations are high-stakes, both for patients and Anesthesia re aerosolization. So we're being pretty conservative re extubation.
- The waxing/waning pattern of hypoxemia confounds this. They may look great after their SBT but be needing 60% by the afternoon or the next day.
- We're not just letting them breathe for 2 hrs on 5/5 and calling it a passed SBT. Make them work harder for longer. I used 0/5 for 4 hours (and I didn't extubate anyone). Don't use T-piece trials (they're aerosolizing).
- Most who've been extubated are extubated to HHFNC, and they stay on it for days (not as a short step-down). It's because they need it. I've wondered about CPAP or BiPAP (again, with a closed-circuit ventilator and a good seal on the face).
- Discussion re tracheostomies. Usually in the unit I usually don't recommend trach until ~2 weeks on the vent. But if the anticipated duration of ventilation is >2 weeks, why not trach them early for patient comfort, minimize sedation, etc.? The VA did this on a patient who was young and had high sedation needs. But Pepe warns that aerosolization risk is higher in a trached patient than in someone with a cuffed ETT. Unclear what to prioritize: conservation of sedatives, patient comfort, conservation of negative pressure rooms, etc..
- ENT is definitely willing to perform tracheostomies (there was a rumor that they weren't).

5) **other clinical features** (extra-pulmonary organ failure, secondary bacterial infections, coagulopathy, rhabdomyolysis, hypertriglyceridemia)

- In my experience, this is largely single-organ failure, more like H1N1 than ebola (isolated ARDS rather than sepsis, multi-organ failure). Some mild AKI (that may be an artifact of muscle breakdown, see below), some heme derangements, but they are typically normotensive with normal lactates and no encephalopathy, even while they are progressing.
- Often once the tube goes in, we see 6-12 hours of hypotension, probably more about sedation and positive pressure ventilation than true shock.
- Certainly worsening of pre-existing conditions (CKD → dialysis dependence).
- Unclear how common secondary bacterial infections are here. Chinese series said ~50% of non-survivors had bacterial lung infections. Seattle said they never found one. I think we're just not looking for them (avoiding bronchs and mini-BALs).
- Lots of empiric antibiotic use, all based on hunches (e.g. a more focal-looking CXR than usual, procalcitonin trends, etc.).
- I think these patients are clotting and at high risk for VTE. Lots of indirect evidence: 1) their D-dimers are uniformly elevated, some sky-high; 2) they

clot off their dialysis circuits all the time; 3) as soon as I started scanning these patients I started finding large BLE DVTs; 4) H1N1 patients had high rates of VTE; 5) I wonder if the sudden cardiac death that other centers are reporting (usually PEA) is just plain old PE. So I'm putting them all on prophylaxis, but am in the dark re whom to test with a DVU (could honestly be justified in most of them). For what it's worth (maybe not much): the positive DVUs were in patients with astronomical D-dimers (>35).

- CK is high in many of these patients, sometimes in rhabdo range. No better explanation other than COVID found. Flu does this. Leo (Renal) pointed out that their serum creatinines rise too quickly to be explained by AKI (i.e. over 24 rather than 72 hours) and probably reflect muscle breakdown more than impaired clearance.
- Triglycerides are high. Some of this is due to propofol, surely, but not exclusively. Some may be due to hemophagocytic lymphohistiocytosis-type physiology. Lots of fentanyl/midazolam use for this reason.

6) **experimental therapies** (hydroxychloroquine, remdesivir, sarilumab/tocilizumab, corticosteroids)

- Infectious Diseases makes these decisions.
- As of last week, everyone was getting plaquenil. That'll probably change (see Tejal's email from earlier today). There's no obvious benefit at the bedside. Needs to be studied. This'll be a PETAL study (along w/ vitamin C).
- They are enrolling for anti-IL-6 therapy (sarilumab) trial. Patients who don't qualify often get another anti-IL-6 drug (tocilizumab). It definitely blunts inflammation (fever drops, CRP drops) but no obvious effect on lung injury, duration of ventilation.
- I was not routinely giving steroids. If you're going to use steroids, probably use the dose and duration in the recent Chinese observational study (methylpred 1-2 mg/kg 3-5 days).
- Frustrating lack of consistency across interventions: steroids definitely decrease duration of ventilation in ARDS and have (inconsistently demonstrated) mortality data behind them, yet we withhold them because of slowed viral clearance in influenza. Yet we are scrambling to give tocilizumab (anti-IL-6) to every sick COVID patient despite zero evidence of clinical benefit and the same theoretical concern for impaired clearance (and MUCH greater cost). Maybe it's foolish to look for consistency in prescribing practices in a crisis like this.

7) **practical considerations** (team structure and workflow in the RICU, PPE, protecting ourselves and our families, provider burnout)

- Didn’t get into this much on the call. RICU service is completely different starting this week. Volume and acuity was definitely too high for 2 intensivists, should be better with more hands on deck.

Michigan Critical Care Collaborative Network

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Notes/Summary