Clinical and team management in the COVID-ICU: Successful strategies from the first weeks

Grand Rounds

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Introduction

- URSMD Grad
- Critical Care and Cardiothoracic Anesthesia, Emory University Hospital
- Large academic hospital system with high acuity
- Initial team of four physicians on-service in 3 different units (luck of the draw), now 7 units
- Helped coordinate best practices efforts since
- Co-credit to my starting comrades, Dr. Sara Auld, Dr. Will Bender and Dr. Lisa Daniel, and numerous others for their efforts since

Objectives and Caveats

- Aimed for those directly providing care to critically ill patients
  - Extrapolate points for floor care
- Adult population only
- Practical, observable, common sense and within standards of care
- Not going to rehash freely available reports
- Observations not rigorously validated
- Outcomes likely to vary based on patient mix, location and resources available
- Have to go fast, more information on slides than can discuss
- More than anything: there is hope and things we can do better

Our starting points

1. The best practice critical care with maximum delivery
2. No luxury of time, get them better FAST for:
   - Sake of patient's chance of recovery
   - Sake of the next patient that will need that ventilator
3. Procedures should be pre-emptive
   - unpredictable and rapid declines
   - Constraints and delays of PPE and provider safety

Prepare Yourself

- Expect barrages of communication and information, often a lot of noise
- There will be long days and nights, just accept it
- Keep your personal uncertainty and fear in check, your team needs reassurance
- Identify colleagues on the front line to share data, experiences and support – then work to institutionalize
- Identify true experts and focus on reliable information
- Sleep when you can, eat when you can

Prepare the Team

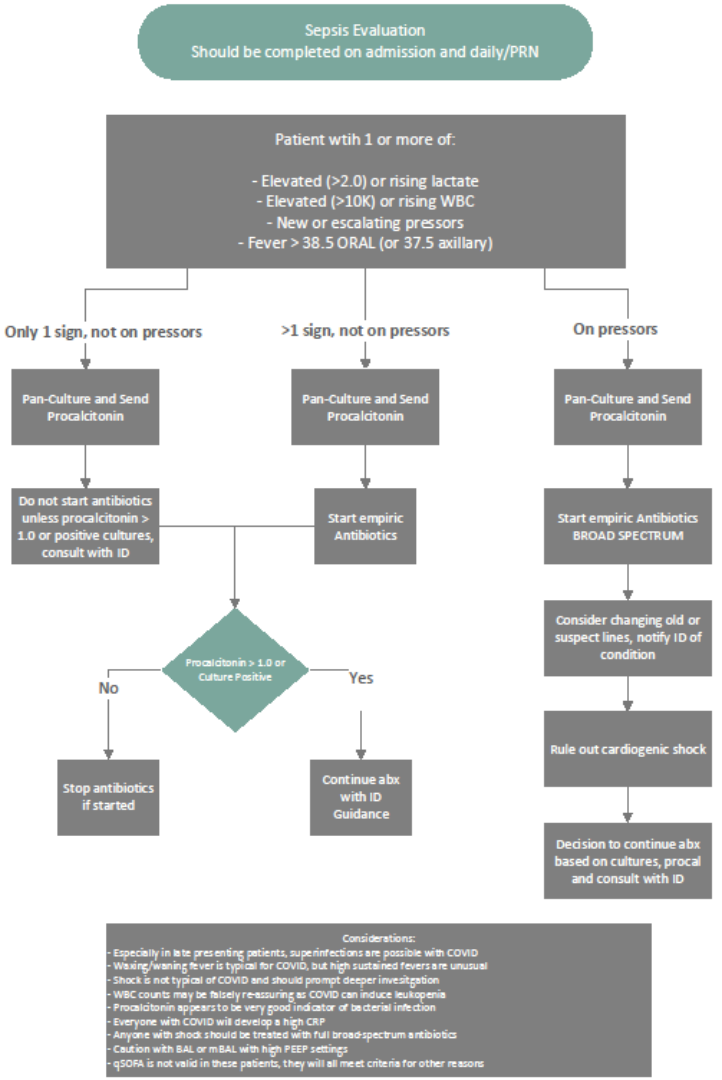
- All leaders: attendings, unit directors, nurse managers
  - Be maximally present, set leader level to “high”
  - Engage with your own leadership
    - don’t assume someone else is taking care of things
  - Cheerleading is a necessary part of this, the message must be “THIS IS DOABLE”
  - Pizza and cookies go a long way with a hard-working team

Prepare the Team

- Daily huddles are critical
  - Single most useful thing that got us through the first week
  - 15 minutes every morning before rounds
  - Include everyone with ANY role in the unit
  - Constant rotation of unfamiliar faces: get everyone on same page
  - Reinforce daily goals
  - Disseminate new information and protocols that will come every day
  - Answer questions and address concerns and fears
  - Identify things that are not working
  - Highlight successes!

Prepare the Team

- Distill practice as much as possible into algorithms and protocols
  - Do not need to be perfect
  - Should make sense for your system
  - Don’t rely on business as usual, be honest about unit’s weaknesses
  - Don’t go it alone, discuss protocols with related experts
    - Cardiology, nephrology, pulmonology (particular CF/bronchiectasis specialists), RT
    - But avoid consulting everyone for every patient, arrive at protocols first
  - Write it up before everything hits the fan
    - May soon have to rely on providers that have little experience



Prepare the Team

- Have mechanism for collation, regular review and dissemination
  - Get buy-in from all units and support services (e.g. RT)
  - Be sensitive to ego threats, but also encourage collaboration
  - Balance wide input with need to move quickly
  - Work in small decisive groups
  - Get administration to back you up
- Provide good continuity
  - No half-hearted sign-outs by email or phone
  - Reinventing the wheel every week will not be possible
  - Figure it out quick, make it scalable

Prepare the Team

- COVID waits for no one
  - Prepare for heightened vigilance
  - Protocols should allow for quick decision points
  - Need to react quickly to changes, 24/7
  - Reassessment and reaction cannot be limited to daily rounds

Disease Course

- As observed, although fair amount of confirmation by others
- Slow plateau phases with rapid, unpredictable transitions
- We observed distinct and consistent phases
- Created our protocols around them in attempt to prevent progression to next

Phase 1 - Prodrome

- Viral syndrome/symptoms
- Often with poor PO intake and/or N/V

Phase 2 – Slow smoldering with silent hypoxia

- Require between 2 – 10L O2, suggest humidified
- Do not feel much SOB subjectively
- CXR with the well described diffuse infiltrates, especially in periphery
- Difficulty mobilizing secretions which can be thick
- Objectively can be mildly tachypneic, purse lip breathing
  - Progressive tachypnea (RR > 25 in adults), should be concerning
- Often require volume resuscitation
  - And often this is overdone to later detriment
- Earlier saw more patients reach hospital at this phase
- Usually before reaches ICU
- Can last for days before progressing, some do recover from this phase

Phase 3 – Struggling

- O2 requirements start to get into 10-15L range NC
- Tachypnea should be concerning even if relatively comfortable
- Coughing requires increasing effort, secretions worse
- More anxiety and subjective SOB
- CXR with progressive consolidation, infiltrates and edema
- Can last from hours to days (often iatrogenically extended)
- Should prompt movement to COVID-ICU and beginning of bundle
- Does not necessarily need to intubated yet, some do recover from this phase (less common)
- Increasingly presenting at this phase or the next

Phase 4 – Respiratory Failure

- Requires NRB, HFNC, NIPPV or Intubation to maintain saturation
- Duration seems dependent on initial mode of therapy
  - Our typical intubation time has been about 5 days for early presenting, 7-10 for those with serious comorbidities or late-presenting
  - HFNC and NIPPV seem to delay time to intubation at the cost of de-recruitment, accumulation of secretions and worse compliance
    - Data for NIPPV strongly suggestive that contraindicated
    - More controvertial for HFNC (e.g. Airvo or Optiflow), mixed results with recoverability

Phase 4 – Respiratory Failure

- Characterized by
  - Relatively normal compliance, even at high PEEP (ARDS but not ARDS)
  - Moderate to severe V/Q mismatch
  - Pulmonary edema
  - Denser consolidations on CXR travelling inwards
  - Initial apparent single organ failure (but other mild derangements)
  - Lack of vasodilatory shock or leukocytosis unless concurrent infection (e.g. line infection, aspiration, bacterial super-infection)
  - Lack of cardiogenic shock (unless pre-existing cardiomyopathy)
  - Thick, copious secretions (may be occult)
  - Waxing/waning fevers (can be high)
  - AKI not related to any hemodynamic or volume status (early ATN, then AIN on microscopy)
  - Rapidly rising CRP that precedes onset (in 200-450 range)

Phase 5 – Death or Resolution

- EITHER relatively rapid progression to MOSF and death
  - Generally we observed in:
    - late presenting
    - Pre-existing severe comorbidities
    - advanced age?
  - Described elsewhere as hyperinflammatory phase
    - Fast onset and short-lived
  - Fulminant viral (?) myocarditis with malignant arrythmias
  - May be amenable to MCS if rapid intervention
- OR slow resolution over 5-9 days to extubation with return to near baseline

Biomarkers

- CK:
  - Generally elevated on admission with early decline, generally not above about 5000
- LDH:
  - Generally rises rapidly and then slow steady decline through entire course
- Troponins:
  - mild, very variable leaks observed as high as 2.0 without clinical significance
- D-dimer:
  - always elevate at least to 10-30K range
  - May see sharp late increases to above scale (>60K) that persist or slow decline after clinical improvement
  - Unknown if correlation with hypercoagulability
- CRP:
  - often admitted with mild increase that then rapidly rises just before respiratory failure
  - Peaks often > 300 or even out of range
  - Decrease seems to precede or coincide with respiratory recovery

Decision points and actions

- 2-10L NC (silent hypoxia)
  - Cohorted floor or ICU depending on overall frailty, subjective experience of symptoms or other ICU-defining co-morbidities (e.g. CHF)
  - Standard floor care or standard ICU monitoring
  - Antibiotics if concern for super-imposed bacterial infection (leukocytosis is suggestive)
  - Pulmonary hygiene
    - Incentive spirometry and chest PT as required (Aerobika/Acapella, saline nebs)

Decision points and actions

- >10L NC or worsening WOB (Struggling)
  - Move to ICU
  - CXR and pre-emptive A-Line
  - Surveillance labs (daily ABG, CBC with diff, CMP, CRP, D-dimer, LDH, PT)
  - Strict I&O's (not necessarily with foley)
  - Guafensin and aggressive pulmonary hygiene
    - almost on par with CF therapy
    - inhaled mucolytics as needed (HTS), incentive spirometry, flutter valve

Decision points and actions

- 15L NC or requiring NRB or >10L with respiratory distress
  - No HFNC or NIPPV
  - Controlled intubation
  - Central line (regardless of pressors)
  - Surveillance labs
    - daily ABG, CBC with diff, CMP, CRP, D-dimer, LDH, PT, ScvO2 and troponin
    - Baseline urine studies (U/A, lytes)
    - Strict I&O's WITH foley
  - For high-risk pts echocardiogram by POCUS or Cardiology
    - stored images for comparison
    - High-risk: >60 yo, prior cardiac history, elevated troponins
  - Begin Phase 4/Intubated management plan
- Alternatively may consider maintaining on HFNC provided:
  - Continue aggressive pulmonary hygiene and IS
  - Tachypnea (RR > 25) or FiO2 > 60% should still prompt intubation

Neuro

- Marked encephalopathy with agitation and high sedation requirements has been uniformly observed (suspect encephalitic component)
- Pulmonary recovery has preceded neurological recovery, waking them up to tolerate SBT is rate limiting step and not easy
- Minimize sedation as much as possible, goal RASS -1 to -2 if pulmonary status tolerates
- Prophylactic restraints – can be difficult to get in room quickly to prevent pulling
- Start physical therapy as soon as patient participatory, even if still intubated

Phase 4 Mgmt –Sedation Comments

- Requires modification of practice that will be the most uncomfortable/inconvenient for both nurses and providers
- Cost of over-sedation is prolonged vent time and delirium that the patient and resource utilization cannot afford
- Vent dysynchrony seemed to CAUSE agitation, not the other way around
- Metabolism of sedatives likely impaired by mild to moderate hepatic and renal dysfunction
- We avoided versed/ativan assiduously, even with paralysis
  - those that got them took significantly longer to extubate (by about 2 days)
  - use BIS monitor if that reassures (goal 50-60)
  - consider the balance of very low risk of recall balanced by risk of mortality d/t vent unavailability
  - If use, stop immediately after discontinuation of paralysis
- Suggest combinations of: propofol, ketamine, quetiapine, narcotics. We used klonopin low dose in some younger. Be mindful of volume with dexmedetomidine
- Be prepared for drug shortages: consider oral or push regimens, may need to get creative
- Accept some increased risk of self-extubations with the PPE delay, snowing them is not the answer

Phase 4 Mgmt - Pulmonary

- Lung protective ventilation – with caveats (ARDS but not ARDS)
  - Compliance relatively intact, even at high peep
  - Peak pressures often low despite normal tidal volumes
- Wean actively and diligently!
  - Can't turn the fiO2 down by 10% each day, must be weaning frequently
  - PEEP wean by -2 every 4-6 hrs only
- In general very responsive to:
  - PEEP
    - usually doesn't need more than 12-14, but can be higher
    - Favor PEEP over FiO2 (aka high PEEP ladder)
  - Early Paralysis
    - Consider single bolus to get control of dysynchrony
    - Half patients improved with intermittent dosing only
    - Don't overdo sedation
  - Inhaled pulmonary vasodilators
    - epoprostenol or iNO
    - There is already a shortage … use selectively
  - Early pronation if fails above

Phase 4 Mgmt - Pulmonary

- Vent modes have been all over the board
- Erratic breathing c/w encephalopathy, persists after lung mechanics improve
- General observations on synchrony:
  - They like to breath normal, variable volumes and with high flow rates
  - PCV generally well tolerated, adjust I-time to patient synchrony, use PEEP for MAP
  - Not tolerated well (unless paralyzed)
    - Volume control (flow-cycled) unless match high flow desires
    - Inverse ratio
    - Low tidal volume
    - APRV (normal compliance transmits high MAP, RV struggles)

Phase 4 Mgmt - Pulmonary

- Prophylactic guafensin, scheduled inhaled mucolytics, frequent suctioning, percussive therapy if needed
- We avoided bronchoscopy at first for theoretical aerosol risk, less concerned currently
- Dry. Them. Out.
- Once on reasonable PEEP/IP requirements, PST or SBT twice daily … try hard!
- Extubate to face mask or HFNC until sure stable (12-24 hours)
- Continue aggressive, scheduled incentive spirometry post-extubation
  - Few bounce back from floors we suspect related to this

Phase 4 Mgmt - Pulmonary

- ECMO
  - Reasonable to consider, but with open eyes to resource utilization
    - Be more conservative on criteria (i.e. triage)
    - Have pre-established, calculated criteria
  - Our triggers include:
    - Ongoing hypoxemia despite paralysis, proning, inhaled vasodilators, PEEP upto +18
    - Failure to progress after 5 days and meets below
    - High consideration for 18-60yo, may have some significant comorbidities, but no prior
    - Age 60-70 without significant comorbidities, especially pre-existing lung disease
  - We ask for early notification to allow for time to consider thoughtfully, use group decisions to eliminate bias in triage
  - Be prepared to say no. A lot.

Phase 4 Mgmt - Cardiovascular

- Maintain good perfusion pressure for renal and hepatic protection (typically we aim for MAP > 75)
- Monitoring for myocarditis
  - Little data on predicting onset, so we are overcautious at this time
  - New admissions get EKG, high-risk get baseline echo
  - Significant, unexplained drop in ScvO2 gets repeat EKG, stat troponin and repeat echo (can be POCUS)
  - Avoid long-acting beta-blockade if possible, use judgement with CAD/CHF
  - New, unexplained or markedly increased pressor requirements should prompt immediate call to attending with repeat ScvO2 and trop. Consider reculture and abx
  - Consider VA-ECMO if function declines significantly, but before it reaches 10-20%
- Correct anemia
- Have a plan for CPR
- Aggressive electrolyte replacement, especially K and Mg

Phase 4 Mgmt - Renal

- Pulmonary and renal congestion will slow recovery
- Diurese diurese diurese
- Don’t assume that rising creatinine is hypovolemia
  - Echo can help differentiate
  - ATN and AIN, even subclinical, has been noted in most of our patients
  - Reminder: FENa with ATN not reliable
  - If creatinine rises, spin the urine for casts
  - Low threshold for dialysis for volume management (assuming adequate supply machines)
- Pressors are NOT a contraindication to diuresis unless in first hours of septic shock
- Consider blood or other oncotic agents (25% albumin) to support diuresis
- Aggressive electrolyte replacement, especially with diuresis
  - Aim for K >= 4.5, Mg > 2.5, Phos > 2.5
  - Ensure that always at goal, not just for the 4 hours post-rounding

Phase 4 Mgmt - Renal

- Dialysis
  - High AKI rate, multifactorial
  - Ideally would use early if volume management an issue
  - Limitations on both machines and cartridge availability
  - Consider PIRRT, IHD or SLED as equipment available and hemodynamics allow

Phase 4 Mgmt – GI

- Immediate placement of Dobhoff tube and initiation of enteral feeds
- HIGHLY suggest bridle
- If no DHT prior to extubation, place one immediately prior while sedated
  - Avoids procedure that involves coughing/gagging
- Good bowel regimen

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Phase 4 Mgmt – ID

- Antivirals
  - Remdesevir: only available now through trial, we highly advocate enrolling
  - Hydroxychloroquine: unclear efficacy, almost certain to run out in near future, we are not generally using unless patient not improving and not in trial. LFT's and QT prolongation
  - Kaletra: reasonable data that is not effective
- Anti-inflammatories
  - NSAIDs are probably safe in our opinion, but controversial
  - APAP cannot be used on Remdesevir trial
  - Steroids are probably harmful, but may be necessary in particular settings (COPD, transplant, etc)
- COVID+ does not preclude other infections
  - Leukocytosis atypical to COVID, suggests other infection
  - Procalcitonin extremely helpful to confirm bacterial infection
  - Shock suggest sepsis or developing cardiomyopathy, is not typical of COVID in isolation
  - Waxing/waning moderate fevers seem typical but sustained high fevers are not
  - Increasingly seeing superinfections in late presenters

Phase 4 (+?) Mgmt - Heme

- Hyperfibrinogenemia, elevated INR (1.5-2.0), low AT3 frequent
- Frequent clotting of CRRT, venous and arterial lines
  - Most CRRT now on hep gtt, increasingly using for other clotting signs
  - Even with citrate or heparin gtts
- Microvascular thrombosis may explain multiple organ dysfunction and progression to MOSF
- Implications for ECMO
  - Using bival as long as available, careful DVT screen post-decannulation
- Seeing some PE even post-recovery
- Early data, unclear what to do, unclear predictors (D-dimer?)
- VTE prophylaxis mandatory even post-ICU, LMWH preferred in scant literature

Avoid

- Experimentation outside of a trial or accepted off-label use
  - however well meaning, it's unethical
- Advice from those without direct experience or recognized expertise
  - Lots of well-meaning colleagues will be forwarding every protocol sent by their friends of friends of friends
  - Pick someone else NOT on service to sift through the chaff
  - Use vetted material, the CDC is a great starting point
- Reinventing the wheel with every change of attending
- Shared ventilators
  - Consensus statement among SCCM, CHEST, ASA and many others
  - Exhaust every other vent option, consider even CPAP bag for spontaneous breathers

Academics

- Don’t need to analyze, but capture capture capture!
- Save echo images
- Trend labs suggested by literature
- SOMEBODY should keep tabs on internal stats
  - We struggle with this
- Idle residents, fellows, post-docs should all be busy chart reviewing, scribing observations and entering data to registries
- SCCM COVID Registry
- ELSO COVID Registry

Patients & Statistics

- Approx 50 known positive patients that were critically ill
  - For my particular hospital
  - Age range 26 – 93, median approx 65
  - Variety of co-morbidities including HTN, asthma, sarcoid, renal transplant, myxedema with TSH > 50, CAD, morbid obesity, CHB
- Approx 40 required intubation
  - Relatively few proning, paralysis, flolan
  - Many high PEEP (14-18)
  - 2 VV-ECMO
  - Approx 12 successfully extubated with continued recovery
  - About half sent to floor on 0-4L O2
  - Majority are still improving
- 3 deaths (rejecting transplant, 93 yo (?MI), and one 25-yo late-presenter)
  - Phenotypes consistent with deaths from flu
- Increasing number presenting and requiring intubation immediately
  - Accordingly increased number of vent days per patient, expect increased mortality as well

How achieved

- Optimally, rapidly and pro-actively provided good critical care across the board regardless of the time of day
- Focus on lung and renal protection, rapid restoration of normoxemia, maintenance of normal physiologic parameters
  - I.e. what we should be doing all the time, but we don't always achieve
- Focus on actually achieving goals, not just having intentions
  - Specifically applies to electrolyte replacement, vent goals and weaning, and diuresis
- Created a bundle of practices/protocols based on phase/progression of disease
- We tried to stuck to our guns and hold ourselves accountable
  - Increasingly difficult as numbers increase and providers change

Final thoughts

- Prepare early
- It will be hard
- There is hope
- It is worth the effort

Thank you to the teams in all my units. I am beyond privileged to work with every one of you everyday, and I could not be prouder of what we accomplished.

Our first extubation