We are the authors behind Oakes' Pocket Guides which have served respiratory critical care and beyond for 35+ years now. We are in a unique position to offer supports by using our expertise in researching, condensing, and presenting critical care data in the midst of the pandemic respiratory therapists are managing. If you are aware of additional resources, information that needs to be updated, etc., please send an email to scot.jones@oakesacademy.com. This is a collaboration - please apply critical thinking to all suggestions, info not cited is clinical advice, not necessarily evidence-based. Also, remember that not all official sources offer validated guidance yet (due to the speed at which we are learning right now). We do not necessarily endorse any specific information.

**PLEASE NOTE:** Feel free to share this page - there are no copyrights attached to our information (some of the links definitely are copyrighted).

A Collaboration of Clinical Guidance for Management of Coronavirus (SARS-CoV-2 virus which causes COVID-19) as of April 6, 2020 (0800) to the source we pulled from

<table>
<thead>
<tr>
<th>Important Disease Knowledge and General Information</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>• Caused by a virus thought to be <strong>Droplet</strong> Transmission but also uncertainty as to whether it is <strong>Airborne</strong>. (JAMA, WHO)</td>
<td></td>
</tr>
<tr>
<td>• Incubation is thought to be 2-14 days after exposure (average is 5 days) (WHO)</td>
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<tr>
<td>• One estimate suggests 3% of all COVID-19 pts require intubation, with about a 50% survival chance on the ventilator (Meng, et. al) to as low as 19% (Weis, et. al)</td>
<td></td>
</tr>
<tr>
<td>• Common in hospital (14%): dyspnea, RR&gt;30, SpO2 &lt; 93%, P/F &lt; 300, lung infiltrates &gt; 50% (Meng, et. al)</td>
<td></td>
</tr>
<tr>
<td>• CT scan is more helpful than CXR (Pan et. al - includes images and breakdown of stages)</td>
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</tr>
<tr>
<td>• CXR likely consistent with ARDS, usually severe (CP)</td>
<td></td>
</tr>
<tr>
<td>• While more rare in children, often presents initially as a mild flu-like illness, more likely to be mild symptoms (Guo, et. al, Wei, et. al)</td>
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</tr>
<tr>
<td>• Avoid PFTs unless critical for immediate treatment, then use only absolutely necessary tests (IPC, ATS)</td>
<td></td>
</tr>
<tr>
<td>• While our scope of practice focuses on respiratory management, complications may also include renal, hepatic, and cardiac involvement</td>
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</tbody>
</table>

Some have suggested multiple phenotypes for the virus (no data to support), each with a different clinical progression (ESICM)
Clinical Progression

- **Phenotype L**: focus is on disregulation of pulmonary perfusion (Low elastance, Low V/Q, Low recruitability, Low PEEP response)
  
  Note that these patients often have normal lung compliances
  
  Consider not using high PEEP - this is not ARDS.

- **Phenotype H**: focus is on pulmonary edema/collapse - ARDS-like (High lung elastance, Higher recruitability, High Right-to-Left shunt, Higher PEEP response)
  
  These patients have lower lung compliance
  
  High PEEP is likely a critical aspect of management

**Watch for signs of deterioration:**

*Note that while onset of symptoms, such as dyspnea, is relatively late (around 6-7 days after symptoms start), the progression to ARDS is quick.* (Wang, et. al, Zhou, et al.)

- Increased O2 needs, especially if supplemental O2 doesn't increase SpO2/PaO2 (suggesting V/Q imbalance)
  
  - Increased A-a gradient with ABG, decreased P/F ratio
  
  - Consider intubation once SpO2 < 90-92% with FIO2 0.60 or higher (CP, ESICM)

- Tachypnea (RR > 30) is quite common with distress,
  
  - so may present as respiratory alkalosis initially (usually with significant hypoxia)

- Indications of shortness-of-breath (speaking in shorter sentences, for example), Dyspnea

- Diaphoresis is concerning sign (indicates potential for near-respiratory-arrest)

- Lack of improvement on noninvasive strategies (HFNC, noninvasive CPAP or NPPV), hemodynamic instability should be seen as a concerning sign (consider intubation)

**Strongly consider Intubation**

**See Resources at the bottom of this page on PPE**

**Remember**: Protect yourself and others from potential exposures. Equipment must be worn correctly to be effective (See CDC 3 Keys for Respiratory Effectiveness, See CDC Mask Seal Self-Check)

**Our Summary:**

1. There is science to suggest that the virus is within droplet nuclei sizing in some circumstances, although we understand the concerns around any possibility of being airborne
2. There is science to suggest that certain activities (see list below) will cause airborne transmission. There is also science to suggest that a sneeze may propel pathogens well beyond a 3-6 foot range (WHO recommends 3 feet, CDC recommends 6 feet) and that droplets may avoid evaporation for minutes afterwards (JAMA)
3. It is critical to wear N95 or above mask without exception for performing aerosol-producing activities (much of what is done in respiratory), and, in our opinion, very important for any same-room
interactions with COVID patients (suspected or confirmed).

**DEFINITE:** Wear all Standard, Contact PPE (gloves, gown, goggles/face shield) and **N-95 or Higher** if any procedure or close contact which is at high-risk for aerosolization exposure - see list below. (CDC, SCCM)

If risk of airborne AND splash/liquid risk, a Surgical N-95 (no exhalation valve) is recommended (CDC)

**DEBATED (vs treating as N-95-or-higher):** Wear all PPE (gloves, gown, goggles/face shield) and Surgical Mask for procedures not in close contact when performing routine care (WHO, SCCM)

WHO: Recommends routine care at a Droplet + Contact level, Aerosol-Producing

For ANY aerosol-producing procedure, including much of what respiratory does, only perform absolutely necessary procedures, and then airborne precautions are recommended (including N-95 or above mask), as well as eye protection, gloves, gown, Negative Pressure room is ideal (CDC, WHO, SCCM). Includes from the sources:

- Manual Resuscitation (bagging)
- Noninvasive Ventilation
- Intubation/Tracheostomy
- Bronchoscopies
- CPR efforts (compressions + bagging)
- Bronchial Hygiene, including Suctioning
- Aerosolized Medications (including Nebulizer Treatments)
- Proning a patient
- Sputum Induction

Note: In the studies reported (see the sources in blue in this section), there is an indication that N-95 masks are safer in all situations, but were not found to be "statistically" so. We recommend protecting yourself from exposure when in doubt, with a consideration for equipment availability in higher-risk situations.

- Clinicians who are reusing N95 masks report placing a surgical mask over the N95 to protect it some

**Intubation**

**Do not delay intubation if the patient is worsening or is pre-code (unstable) - Proactive Intubation is Preferred (APSF)**

**If trialing HFNC or BiPAP/CPAP: if no improvement within 1-2 hours (distress, RR, P/F<150), intubation is recommended (Meng, et. al)**

**Intubation is high-risk for exposure - take every precaution**
possible.

Preparation

- **Personal Protective Equipment:** Airborne (a must!) + Contact
- Least # people possible in room, close door during intubation and for a period after (WHO)
- Consider use of a covering over patient's head during intubation - large clear trash bag, O2 tent, etc., to decrease aerosolization risks [SEE 1 Video Demo], see NEJM correspondence. Citizens-Against-COVID-19 offers enclosures for intubation at no cost
- Use of (preferably dedicated or disposable) fiberoptic equipment is highly recommended. It prevents exposure (looking directly into the airway) and improves chances of intubating successfully ([see video demo from ATS](https://www.atsjournals.org)) (APSF)

**Oxygenating**

- Either NO bagging (use NRB to minimize aerosolization) OR Hepa/Viral filter in between Resuscitator Bag and Mask with GENTLE breaths only ([APSF, CTS, Wax & Christian, Sorbello, et. al, Cheung, Tran, et. al](https://www.atsjournals.org))
- Consider passive supplemental oxygen with NC during intubation attempts (6 L/min) - do not use HFNC due to exposure risk (Sorbello, et. al)

- Team should have a discussed plan, all know part, closed-loop communication at all times. Consider Mock Intubations to practice (APSF)
- Because the goal is to minimize all exposures (and disconnections), the ventilator should be ready, in stand-by, Resuscitation bag should be ready with filter
- **There is no "Emergency" intubation** - all PPE must be donned appropriately to minimize risk

During Intubation

- Prioritize using the person who has the most experience/skill with intubating to avoid multiple attempts.
- When possible, oxygenate for 5 minutes before RSI (using NRB if not bagging) ([APSF](https://www.atsjournals.org))
- **Expect no respiratory reserve** (due to hypoxemic respiratory failure): SpO2 may drop quickly during attempt ([Meng, et. al](https://www.atsjournals.org))
- Use Rapid Sequence Intubation (RSI) unless difficult airway identified (assess the airway if time) - RSI should decrease time, decrease cough-risk during attempt
- If possible, have 2 people confirm ET tube through vocal cords (especially if not using colorimetric ETCO2)
- If unable to obtain airway, may need to provide GENTLE breaths with Resuscitation bag (if using), some recommend Max 2-3 attempts, then place supraglottic device (such as LMA) ([Sorbello, et. al](https://www.atsjournals.org))

Post-Intubation

- **Finger occlude ET tube as soon as it is placed and stylet**
Airway Management

- out, then place on vent (or bag), Clamp ET tube if any delay (Kelly Clamps, 4x4 Gauze)
- **Reports are that patients are rapidly desaturating right after intubation** (derecruitment?)
- Some hospitals report intubating, then placing directly on ventilator for tube placement confirmation with ETCO2 (again, this avoids droplet aerosolization) = avoiding colorimetric capnography (EZ-Cap). If in-line ETCO2 not an option, consider using alternative methods of confirming placement - chest rise on vent, breath sounds, depth marking on ET tube, then follow-up CXR.
- Consider immediate recruitment maneuver, or place on higher PEEP (10-12 is typical to start)

**Extubation**

- **Most prefer a protected extubation which means treating as a very high-risk procedure and minimizing exposures at each step**
- Normally many clinicians take an aggressive approach to weaning and extubating. There are some anecdotal reports of patients having early replapses, so keep that in mind before extubating (GIVIT Mtg). Extra caution now due to the exposure risks that would be associated with reintubation.
- Airborne and Contact precautions required - this is a high-risk for aerosolization procedure
- Limit the number in the room (preferably 2) (Tan, et. al)
- **Recommended Procedure** (Tan, et. al)
  - Pre-oxygenate (FIO2 1.0 x 3 minutes)
  - Gentle oral suction
  - Suction through in-line suction via ET tube
  - Remove ET tube stabilization/tie while holding ET tube in place
  - Turn ventilator to Stand-by or OFF (especially if it could auto-restart), cap end
  - Deflate cuff and extubate - no further suctioning, do not instruct patient to cough
  - Others (not source cited) recommend having in-line suction ON when deflating cuff, leaving suction on through the extubation maneuver to minimize aerosolization.
  - Place O2 mask on patient immediately to minimize cough exposure (most recommend not using NC, consider NRB mask or Venturi mask)
- Remain cautious about considering NPPV or HFNC as a bridge post-extubation (ANZICS), others recommend avoiding if possible (Tan, et. al)

**Unplanned Extubation:** Not an emergency - MUST take the time to put Airborne and Contact PPE on correctly. TURN OFF VENTILATOR as soon as safely possible. Place on NRB mask if not using manual resuscitation in hospital, if using consider 2-handed technique with bagging to avoid exposure. Assess patient for need for reintubation. (Tan, et. al)
**Terminal Extubation:** Some facilities report placing patients on Room Air, CPAP +5 instead of extubating with the goal of preventing unnecessary exposure/aerosolization risk. If patient dies prior to extubation, airborne and contact precautions still necessary, ENSURE VENTILATOR IS OFF BEFORE DISCONNECTING.

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**General Airway Management**

*All tasks should be performed with the goal of minimizing exposures, avoiding aerosolization of secretions*

- **Minimize disconnects from vent whenever possible**
  - When disconnecting from vent circuit:
    - consider clamping endotracheal tube (use flat Kelly Clamp (no teeth with a 4x4 gauze) until reconnected to bag-valve-mask, etc. or cover the end of the vent circuit with a gloved hand while disconnecting to minimize aerosolizing droplets
    - Some report a bolus of sedation if necessary (avoid coughing) *(Sorbello, et. al)*
    - Some report placing ventilator in stand-by mode prior to disconnecting/clamping *(Sorbello, et. al)*
  - Use a **HEPA, viral/bacterial filter** between Resuscitator Bag (BVM) and the artificial airway.
  - If possible, avoid procedures that increase exposure-risk, including trach placement/change, bronchoscopies, etc.
  - Ensure cuff pressures between 25-30 cmH2O (ensures appropriate seal with airway)

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**Oxygenation Progression of Care, may deteriorate quickly**

**SpO2 Goals (WHO, GOLD, SCCM)**

<table>
<thead>
<tr>
<th>Adults with severe COVID (distress, hypoxemia, shock)</th>
<th>Evidence Varies, with lower goals as low as 88% reported <em>(Wax &amp; Christian)</em></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>92-96% SCCM</strong> <em>(SCCM suggests low threshold of 92%, but recommends that threshold be no lower than 90%)</em></td>
</tr>
<tr>
<td></td>
<td>90-96% WHO</td>
</tr>
<tr>
<td></td>
<td>88-94% AHA</td>
</tr>
<tr>
<td>once stable</td>
<td>&gt; 90%</td>
</tr>
<tr>
<td>once</td>
<td>&gt; 90%</td>
</tr>
</tbody>
</table>
**Oxygenation Targets**

<table>
<thead>
<tr>
<th>Oxygen Delivery</th>
<th>stable, pregnant</th>
<th>92-95%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pediatrics initially (severe distress, cyanosis)</td>
<td></td>
<td>≥ 94%</td>
</tr>
<tr>
<td>once stable</td>
<td></td>
<td>≥ 90%</td>
</tr>
<tr>
<td>Adults with COPD</td>
<td>DO NOT WITHHOLD OXYGEN Goal per normal (no less than 88%)</td>
<td></td>
</tr>
</tbody>
</table>

Many clinicians are reporting a consensus in progression of care:

1. **Initiate with Nasal Cannula** (WHO recommends starting at 5 L/min)
2. **Progress to 6 L/min** (some avoid humidifying)
3. **Switch either to nonrebreather mask (15+ L/min) or going directly to intubation.** Proactive intubation is advised.
   *If increased WOB after O2, V/Q mismatch may exist and intubation is indicated*

**Support for Skipping noninvasive and going directly to intubation includes:** APSF,

It is difficult to assess consensus on noninvasive applications (HFNC, CPAP, NPPV), as many are unsure how to balance risk of exposure/aerosolization with the need for bridge therapies, especially when they don’t use needed critical care ventilators, as is particularly true of HFNC. We advise caution, with an emphasis on healthcare professional safety (anyone in room with patient) overriding all concerns.

**Remember:** Consider Intubation while it is proactive/routine - don't wait for an emergent situation

**Considerations**

- Most people agree that due to exposure risks, **airborne precautions** should be used with either, and a negative-pressure room is preferred
- Either modality is probably more likely to fail than succeed, so consider a **short trial if using (1 hour)**
Noninvasive Ventilation

- Must monitor closely: **if any indication of failure or instability: discontinue and intubate.**
- Less clear is the use of CPAP/NPPV for patients with OSA or malacias. Minimally, it may be worth considering transition to NC at night, if possible, or from nasal pillows or nasal mask to a face mask with a dual-limb circuit (and HEPA/viral filter)

**High-Flow Nasal Cannula (HFNC):**

- Why it might be okay: Typical cough is 300-400 L/min, High flow is typically 60 L/min or less, thought to be minimal exposure when prongs are appropriately sized and placed
- Why it might not be okay: Concern for risk of exposure with a high flow "blower" dispersing virus throughout the environment
- Evidence: Limited, but SCCM recommends (if supplemental O2 not working, prefers over NPPV), WHO recommends, CP advises against. AHA recommends at lower flowrates over CPAP/NPPV. One study prefers over NPPV (Bouadma et. al), but another suggests most people fail on HFNC (Zuo, et. al)
- Modifications:
  - Consider lower rates of flow (15-30 L/min versus 30-60 L/min, should still equal minute ventilation)
  - Consider surgical mask on patient over patient-interface (CTS)
  - Strongly consider negative-pressure room (or closed door, minimally) and airborne precautions
  - Stop flow before removing device (Tan, et. al)

**Noninvasive CPAP**

- Why it might be okay: Increased mean airway pressure - while not using ventilators, doesn't augment breaths (supports lung protection)
- Why it might not be okay: Achieving an adequate seal on mask can be a challenge, any leak increases risk of aerosolization/risk to healthcare providers, higher CPAP level may increase risk of leak, CPAP assumes minimal WOB - pH acceptable (as a reflection of PaCO2)
- Evidence: See this excellent article on CPAP for COVID (Josh Farkas). AHA strongly recommends against.
- Modifications:
  - Extra care with mask-fitting and adjustments (high-risk)
  - Use HEPA/viral filter (expiratory side)
  - If possible, avoid using a mask with an exhalation port, consider dual limb circuit (requires critical care vent which may use critical resources)
  - Titrate CPAP to SpO2 goals - but do not exceed 20 cmH2O (gastric insufflation) - also remember, the higher the pressures, the greater the risk of leaks, and the tighter the mask the greater risk for skin breakdown issues
  - Stop flow before removing device (Tan, et. al)
Noninvasive BiPAP (Noninvasive Positive Pressure Ventilation or NPPV)

- Why it might not be okay:
  - Hypoxemia and thus respiratory arrest can progress rapidly
  - Significant increase in risk of transmission to Therapist, others (Wax & Christian).
  - Poor mask fit, leaks around mask, taking mask off - all common and increase risk
  - Very high failure rates (76% failure in Chinese study)
  - High respiratory drive: self-injurious breathing. This occurs when rapid number of breaths, large breaths, with large pleural pressure swings can accelerate ARDS pathways (MGH)
- Evidence: Consider use of NPPV or nothing (so, avoid HFNC) - SCCM recommends if HFNC not available and no urgent indication of need for intubation. AHA strongly recommends against.
- Modifications/Strategies:
  - Use a dual-limb circuit if possible, filters placed at equipment outlets
  - If single-limb circuit, consider HME between exhalation port and mask (CTS) SEE IMAGE of SETUP
  - If possible, avoid using a mask with an exhalation port
  - Use a higher EPAP if tolerated (do not exceed 20 cmH2O due to high risk of gastric insufflation).
  - Stop flow before removing device (Tan, et. al)

Other Considerations

- Some hospitals even recommend transitioning from NPPV to NRB Mask if change to suspected/confirmed COVID (CP)
- DNI: Most report using NRB mask instead of HFNC or NPPV in these patients (CP)
- Bubble CPAP may be needed for newborns/children with severe hypoxemia when other equipment is unavailable (WHO)
- Experience from China has reported very high failure rates for noninvasive techniques. Keep this in mind as you consider intubation vs. noninvasive
- Any indications of ARDS (V/Q mismatching through P/F ratio, for example) should push towards intubation over noninvasive (you are otherwise delaying the inevitable)

The primary goal is to support the lungs (Supportive Care) until the virus has passed. Lung Protective Strategies prioritize protecting lungs during an active infection and we often adopt a mentality of "Minimum Acceptable" standards, such as minimally acceptable oxygenation, instead of normalizing.

Primary Goals are consistent with ARDSnet with variations noted below (download protocol here):
Invasive Ventilation

- **Lung Protection (Plateau Pressure ≤ 30)** - note Pplat may be higher with severe obesity or abdominal compartment syndrome
- **Support Minimum Oxygenation Goals (PaO2 = 55-80)** to prevent hypoxia / SpO2 88-93%
- **Support Minimum Ventilation Goals (pH > 7.20)** to maintain lung protection

Consider need to prevent spontaneous breathing due to high respiratory drive, large pleural pressure swings, which may worsen lung injury and worsen compliance. Place patient on controlled mode of ventilation (see below), consider use of deep sedation and/or paralytics to prevent injury. (MGH)

Sedation Note: Sedation should be deep enough to ensure ventilator synchrony (to prevent potential lung damage), and if deep sedation (RASS -5), but still dyssynchrony, may need to consider paralytics. (CP)

Most reported prolonged periods of mechanical ventilation being required with extubation coming 8+ days after vent initiation (NEJM)

**Ventilators**

**For specific ventilator advice, consider PSRC (Pennsylvania Society)** - including stockpile ventilators

Use HEPA filters on vents (recommend treating as airborne for now), or viral/bacterial filter if HEPA unavailable

Some clinicians are reporting atypical lung compliances (higher than expected, >30) with very low P/F ratios (<100). It is highly suggested that lung protective strategies are still followed carefully. See notes above, also, on phenotype theory.

**Mode**

There is no evidence to support any one mode over another, although there is anecdotal evidence that we should avoid spontaneous breathing (due to risk of self-injurious breathing). Some resources are recommending Volume A/C, though there is no specific evidence to support.

**Tidal Volume** (Set or Target):

**Start at around 6 mL/kg Ideal Body Weight (IBW)** (IPC, WHO). 4-8 mL/kg (SCCM)

If Compliance is normal, consider starting at 8 mL/kg IBW (ESICM)

- If Plateau is 30 or greater, drop tidal volume by 1 mL/kg IBW at a time until Pplat under 30 or at 4 mL/kg IBW (ARDSnet)
  (do not go under 4 mL/kg IBW as this will approach dead space ventilation)
• **As you decrease VT, you will likely need to increase RR.** Consider increasing 5/min for each 1 mL/kg drop in tidal volume. For the most part we don’t exceed a RR of 30-35/min due to air-trapping (not enough time to exhale)

• May need to actually **INCREASE VT** up to 8 mL/kg IBW (ARDSnet usually starts here) **only if significant dyssynchrony or pH < 7.15 (WHO)**
  
  Deep Sedation may also be required

• **Pediatric:** use target Pplat < 28, pH 7.15-7.30, VT 3-6 mL/kg with poor compliance, 5-8 mL/kg with better compliance

**WHO**

### Clinical Tool: ARDSnet IBW and VT Calculator

**Rate**

Preferably start at whatever rate needed to match baseline MINUTE VENTILATION, but if initiating consider around 20/min to start, then titrate per ABG (see ABGs, below. See Inspiratory Time)

Avoid rates above 35/min (remember, do not normalize pH)

**Inspiratory Time**

Typically around 0.9-1.0 second, may need to consider shorter TI especially at 6 mL/kg IBW and below (0.7 or 0.6 sec).

Either way, ensure adequate exhalation (flow scalar should return to baseline) unless APRV where "therapeutic air-trapping" is employed.

**PEEP**

Use higher PEEP strategies if **PEEP responsive** (oxygenation improves with increase in PEEP level) (IPC, SCCM). **Clinician reports from around the world suggest that most patients are PEEP-responsive, with PEEPS of 10-12 being helpful, sometimes higher.**

- Higher PEEP is suggested to be > 10 (SCCM). If PEEP is too high: P/V Loop with beaking; cardiac output will decrease; BP will drop - this indicates overdistension of alveoli, DECREASE PEEP
- Perform an optimal PEEP maneuver if knowledgeable in how to do so

*Some evidence for maintaining a driving pressure (Pplat-PEEP) of under 12-15 by adjusting VT and PEEP) if no spontaneous breaths (Meng, et. al)*

**FIO2**

Prioritize use of PEEP over FIO2 when possible. Increasing FIO2 without adequately recruiting alveoli (PEEP) will result in only minimal increases in PaO2. High FIO2s (1.0 or 100%) may result in further atelectasis from nitrogen washout

**Humidity**
There is no current consensus on HME vs. Heated Wire. More evidence is supporting HME placement to minimize aerosolization risks.

**WHO** recommends changing HME every 5-7 days or when soiled/not functioning

### PRONING

**There is a strong consensus that proning a patient is a critical step in management.**

(Proning may improve ventilation-perfusion matching which can increase oxygenation)

**Proning is considered an aerosol-generating procedure due to the risk of coughing/disconnect. Use Airborne PPE if possible**

**Proning Guidance/Consensus**

- Emphasis is on early proning (**Ding, et. al; Sun, et. al; Agrawal, et. al; Kallet, et. al**)
- Patients should be considered to be proned as soon as on a ventilator, but if not, definitely if P/F ratio (oxygenation) is not improving satisfactorily with other strategies
- Deep Sedation (RASS -4 to -5) should be considered while proning
- After proning, wait about an hour, then recheck ventilator parameters (Pplat, PEEP, VT) - make changes as necessary (CP)
- **Prone for no less than 6-hours at a time** (multiple sessions per day), but preferably 12-20 hours/day (**JAMA, WHO, SCCM**)
- Avoid using Hollister-type securing devices due to risk of skin breakdown; consider twill-type instead
- Some recommend d/c prone once patient is sustained in stable state (FIO2 needs, Pplat, ABG, P/F)

- **If patient in prone requires CPR, AHA supports starting compressions in prone position, then turning patient to supine as quickly as can safely be done.**

- **Pregnant:** recommend use of lateral decubitis position, not proning (**WHO**)
- **Pediatrics:** consider proning with indications of severe ARDS (**WHO**)

**Proning Resources**

- **More Information/Instruction on Proning:** Uptodate, NEJM, RespiratoryCare
- Helpful Instruction for teams not used to proning: Rush
Note: This text is a summary of critical care strategies and information. For detailed information, please refer to the original sources.

**Other Critical Care Strategies**

- **University**
  - Learning module on Proning from Osler

**Other Feedback/Information**

- **Airway:** RT should always be present to prone or supine a patient - securing the airway and avoiding disconnect is absolutely critical
- Skin breakdown can be more difficult to monitor/control - consider twill-type ties vs. Hollister type securing devices
- Some clinicians recommend proning higher-risk, nonintubated patients on a nasal cannula if indication of V/Q mismatch (such as low P/F ratio) - (Sun, et. al.)

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**Recruitment Maneuvers**

Use with caution (watch closely for any desaturation, hypotension, barotrauma. STOP maneuver if any of these occur) but some recommend use of a recruitment maneuver. (SCCM)

Suggested: Place patient on CPAP 35-40 cmH2O for 40 seconds (SCCM), some recommend less time for safety - like 15 seconds (ESICM)

Do NOT: Perform Incremental PEEP recruitment (increasing PEEP from 25 to 35 to 45, each level for 1-2 minutes) (SCCM)

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**iNO or inhaled prostaglandins**

- There is limited evidence to support use of iNO (SCCM says no, MGH suggests is viable)
- Some recommend short trial of inhaled pulmonary vasodilators- taper off if no effect (SCCM)

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**NMBA**

to manage ventilation of COVID patients, some combination of deep sedation and possibly paralytics might be necessary, especially if:

- Dyssynchrony with ventilator
- Plateau Pressures over 30 despite other attempts (such as PEEP, low VT) to lower

If needed, consider boluses vs. continuous initially. If persistently high plateau pressures, consider 48-hours of continuous SCCM

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**ECMO**

Consider V-V ECMO when other options have already been optimized but P/F ratio is still poor - evidence on 60-day mortality has been inconclusive, so use extreme care in allocating this resource (WHO, SCCM)

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**Multiple Patients on a Single Ventilator**
Our official position is in line with the majority of respiratory and medical professionals: **Multiple Patients should not be put on a single ventilator.** The risks (including causing damage to all lungs being ventilated, increased cross-contamination, exposure risks due to more frequent disconnects) outweighs the benefits (stretching limited equipment/resources). MAJOR considerations include the need for both sets of lungs to have very similar lung mechanics (compliances, resistance, respiratory quotient, BMI, etc.), the driving pressure (Pplat-PEEP) needs to be identical, and the needs the same (acid-base, including metabolic component to a degree, PEEP, inspiratory time, total rate). If hypothetically able to match and maintain match (nearly impossible), these variables would need to stay the same in both patients the entire time (impossible). At best this would require a Respiratory Therapist be very close to bedside, constantly monitoring, all the time.

A major joint statement has been published on the matter:

**See the Joint Statement on Multiple Patients per Ventilator**
(SCCM, AARC, ASA, ASPF, AACN, and CHEST)

**Last-Resort Alternative to Multiple Ventilators:**

Manual resuscitation (bag the patient) with a viral filter. Preferred use with an O2 blender, possibly a PEEP valve. While healthcare resources would be unlikely to allow for this, consider use of a family member to provide manual ventilation. Again, this is all "last-resort" thinking.

### Troubleshooting

For any sudden deterioration while on ventilator consider pneumothorax, more common with SARS. Consider use of ultrasound to r/o if portable CXR delayed. *(Wax & Christian)*

Flow not returning to baseline (flow scalar or flow-volume loop): Check: inadequate exhalation (decrease TI), bronchospasm (bronchodilator)

Plateau pressure above 30: Drop VT by 1 mL/kg until at 4 mL/kg

O2 below goal: Optimize PEEP, Prone Patient, Recruitment Maneuver, Paralytics, Inhaled Pulmonary Vasodilators (not iNO), ECMO

### Bronchoscopy

**High-Risk due to potential exposures: priority use of PPE (N-95, Face shield, gown, gloves) - avoid use if possible!**

- Do not use to r/o COVID-19, but consider for mucous plugs or to specifically r/o alternative diagnoses (TB, other pneumonias) **IPC**
- Sputum specimens should be obtained by closed suction with endotracheal tube with COVID sampling preference for lower
Bronchial Hygiene and Other Considerations

- Limit to therapeutic indications such as hemoptysis
- Minimize disconnections, use of bronchoscopy adapter on ET tube is recommended
- Consider placing mask on patient during bronch if not intubated (minimizes exposure)
- Use of disposable bronchoscope, if possible

Suctioning and Bronchial Hygiene

**Strong preference for closed suctioning only (in-line suction) when intubated** (WHO, CTS)

-minimizes aerosolization exposure, decreases derecruitment of lungs (alveoli collapse)

Avoid open suction techniques, including nasotracheal suctioning, open suction of the tracheostomy/stoma

**If absolutely necessary, treat as a critical activity with priority on PPE (N-95 mask or higher level, face shield, gown/gloves).**

Avoid Bronchial Hygiene Therapies that may increase risk of cough when possible (chest physiotherapy, IPV, etc.) (CTS)

(特殊情况：导致异常分泌物的疾病，如囊性纤维化，支气管扩张，etc.)

Aerosolized Therapies

Avoid therapies that produce aerosols whenever possible. Use MDI with spacer over Nebulizer. One study showed active virus 3-hours in air sample after a nebulizer treatment (assuming not in a negative pressure room) (Munster, et. al)

Aerosolizing drugs/treatments should be considered HIGH RISK *treat as Airborne with N-95 or higher mask CMAJ, CP

Use HEPA filters if possible when needed AHA

All aerosol-generating procedures should be done in negative pressure room if possible. Second best is a portable HEPA-filter in room (SCCM)

Choosing a Drug-Delivery Therapy (in recommended order of preference, based on exposure risk, not drug deposition, etc.):

1. **Use an MDI (with spacer) when possible.** Consider shared cannister protocol to preserve aerosolized drug availability. Use MDI adaptor/HME on vent circuit.

2. **Consider breath-actuated neb (BAN) with filter, or a breath-actuated vibrating-mesh neb to minimize number of breaths required (for example, if MDI unavailable)**

   - Specific to: 2.5 mg (0.5 mL) of Albuterol, with no saline and no additional drugs
3. **Use a filtered nebulizer** (such as those used with pentamidine, or with HEPA/viral filter placed)

4. **On Vent, consider vibrating mesh neb in-line with extra filter at the expiratory port during treatment (CTS)**

<table>
<thead>
<tr>
<th>Arterial Blood Gases</th>
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<tr>
<td><strong>Use a lung protective strategy with ABG management</strong> (permissive hypercapnia via pH management, lower PaO2 than normal)</td>
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<tr>
<td><strong>Monitoring trends by ETCO2, SpO2 is helpful. SpO2, in particular, may be a later sign of distress in patients with cardiac muscle dysfunction secondary to COVID.</strong></td>
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| **pH:** Keep pH above somewhere **> 7.15, though > 7.25 if possible** - no need to normalize (normal is 7.35-7.45)  
  if pH under 7.15 after vent changes, consider 1) Deep Sedation, then 2) Paralytics CP   Either way, consider proning |
| **PaCO2:** less important than pH - treat pH not PaCO2 in patients with significant lung disease |
| **PaO2:** Keep minimum acceptable PaO2 goals (60 or higher is reasonable, normal is 80-100)  
  *Consider increasing PEEP if PaO2 is below the goal |
| **Oxygenation:** A-a Gradient, P/F ratio, Oxygenation Index may be better indicators of oxygenation when there is a V/Q mismatch as is likely with these patients |
| **Clinical Tool:** A-a Gradient Calculator |
| **Clinical Tool:** Oxygenation Index Calculator |
| **Clinical Tool:** PaO2/FIO2 Ratio Calculator |

**All CPR activities should be performed using Airborne Precautions and should limit the number of people present AHA**

**Protected Code Blue**

- Take the time to put all appropriate PPE on (Airborne + Contact, check PPE)  
  - Attempt to minimize number of people in room (3 is seen as ideal)
To minimize exposure risks, some hospitals are performing a single round of CPR, then discontinuing further efforts.

**CPR for Non-Intubated Patients**

(may result in aerosolizing the virus, increasing risk)

(pediatric patients often code secondary to respiratory arrest, so increasing oxygenation by ventilating may be a critical step)

- Initiate with Compressions First, even if suspicion of Respiratory Arrest
- Many (or most?) are not using bag-valve-mask ventilation to minimize exposure-risk.
  - Consider Intubating more Quickly, some practice compression-only CPR until airway is established (CP)
  - Consider use of a nonrebreather mask if not bagging to allow for some passive oxygenation (unlikely), and to minimize aerosolization during compressions.
- If decision to use BVM: consider use of a HEPA or Bacterial/Viral Filter in-between bag/mask and ensure a TIGHT seal against face - may require 2-people to do so
- While minimizing overall interruptions in compressions, consider pausing chest compressions to allow for more accurate intubation (less particle spread)

**CPR for Intubated Patients (or with artificial airway)**

- Consider leaving on ventilator during code.
  - Consider dropping set rate to 10/min
  - Consider lowering PEEP to optimize for venous return to heart
- **Defibrillating on Ventilator**
  - Risk: while extremely rare, reports of fires/arcing in the presence of an oxygen-enriched environment
  - Reason to Consider: any disconnect of the airway/vent circuit increases aerosolization risk to those in room
  - **Modifications to Consider if Leaving on Vent:**
    - Drop O2 below 50% and ensure any exhalation is 30 cm (12 in) away (APSF)
    - Consider pausing the ventilator during defibrillation - extra measure of safety despite closed circuit (APSF)
    - DO NOT disconnect the vent circuit and leave on patient - increases risk (AHA, ECRI)

**CPR for Patients who are in Prone Position**

Note that if proning patients, coding is a bit more complicated. Most clinical sources, as well as 2010 (not updated 2015) AHA guidelines, recommend beginning CPR in prone position. It would be reasonable to then get patient into supine position as quickly as is safely possible. Again, high priority should be placed to avoiding disconnect of an airway to avoid exposure.
**Respiratory/Critical Drugs**

Evidence is mixed on use of systemic steroids and probably should be limited to treating other indications, such as Asthma and COPD (WHO). Inhaled steroids should be continued, MDI when possible.

**Avoid corticosteroids** (may prolong illness) unless using for underlying disease. This is primarily true of SYSTEMIC steroids. (CDC, WHO)

- COPD: use caution with systemic steroids, but there's no evidence that inhaled/oral steroids should be avoided (GOLD)
- Asthma: Continue all inhaled drugs, as ordered (GINA)
  - For severe Asthma, lowest-effective-dose of inhaled steroids as possible (GINA)
  - as indicated but with more caution than normal (especially systemic, less so for inhaled)
- For shock, low-dose steroids should be considered (over giving none) (SCCM)

**Avoid drugs that induce cough whenever possible** (mucokinetiks such as acetylcysteine, hypertonic salines)

- Consider careful use with patients with abnormal secretions related to diseases - Cystic Fibrosis, Bronchiectasis, as needed when appropriate PPE is available, negative pressure rooms are preferred
- iNO not preferred, but inhaled prostaglandins can be trialed briefly as a rescue therapy
- Asthma Exacerbation: Consider use of Albuterol by MDI with spacer initially for exacerbation, every 20 mins x 3 doses. Consider IV mag if needed. Avoid continuous albuterol due to aerosolization risk unless absolutely necessary. Be aware of need for early intubation (CHOP). Systemic steroids should still be considered in severe asthma exacerbations (benefits may outweigh risks) (WHO)

**Transport Considerations**

Avoid transport when possible, including limiting away-from-room imaging/procedures to absolutely essential for treatment only

- N-95 Masks if possible, as well as eyewear, masks, gown, gloves
- Minimize, eliminate transport except to admit to ICU, absolute necessary transports
- Minimize number of healthcare professionals on transport
- If intubated: use transport ventilator, if available. If no transport vent available, consider bagging with PEEP valve
- If not intubated: use non-humidified oxygen (avoid further aerosolization) and patient should wear a procedural mask
Weaning/Discontinuation

**Very little guidance on weaning at this time**

- Reports are that some wean off around 8-10 days, but that many require **15-20 days of ventilation** before being ready to discontinue from vent *(NEJM, MGH)* - patience!
- Ventilator Criteria to Consider
  - Meeting oxygenation goals with FIO2 < 0.4, PEEP < 8-10 on PSV < 10 *(Tan, et. al)*
  - Secretions should be minimal/manageable (some reports are lots of secretions for COVID pts, others report minimal)
  - Consider less-aggressive weaning/extubation (with goal of avoiding need for HFNC/NPPV post-extubation, often difficult wean initially), *(MGH)*
  - Avoid use of T-Piece trials, including with trach patients (as well as trach mask). Use pressure support weaning instead *(CTS)*