Basic Info

- Caused by a virus thought to be Droplet Transmission but also uncertainty as to whether it is Airborne. (JAMA, WHO)
- Incubation is thought to be 2-14 days after exposure (average is 5 days) (WHO)
- Current evidence supports a patient having immunity once recovered - presence of antibodies (CDC)
- One estimate suggests 3% of all COVID-19 pts require intubation, with about a 50% survival chance on the ventilator (Meng, et. al), some report mortality as high as 81% (Weis, et. al)
- Severe (dyspnea, hypoxia, > 50% lung involvement) occurs around 14% of cases, Critical (resp failure, shock, multi-system organ failure) occurs around 5% of cases (CDC)
- Overall case fatality is around 2.3%, but closer to 50% in those with severe COVID-19. ICU mortality ranges from 39%-72% (CDC)
- Imaging - arguments for CXR if resources are limited, otherwise consider CT scan (Fleishchner Society, CDC, Pan et. al)
  - Imaging indicated for mod-to-severe features (hypoxemia, dyspnea)
    - worsening of respiratory status (Fleishchner Society)
  - Daily chest radiographs are NOT indicated in stable, intubated patients (Fleishchner Society)
- 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)
- Avoid PFTs unless critical for immediate treatment, then use only absolutely necessary tests (IPC, ATS)

<table>
<thead>
<tr>
<th>Some have suggested multiple phenotypes for the virus (no data to support - purely theoretical), each with a different clinical progression. Easy way to differentiate? Check the Lung Compliance. (Gattinoni, et. al; ESICM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Take-Home Message: pay attention to the &quot;story&quot; your assessment is telling you. Most major consensus supports ARDSnet strategies currently (lung protection), but information is changing quickly, too:</td>
</tr>
<tr>
<td><strong>Phenotype L:</strong> focus is on hypoxia-driven disregulation of pulmonary perfusion (Low elastance, Low V/Q, Low recruitability, Low PEEP response)</td>
</tr>
<tr>
<td>Note that these patients often have normal lung compliances, good plateau pressure, lower driving pressures. Consider not using high PEEP - this is not ARDS (high PEEP may worsen V/Q matching in this case, may affect cardiac function, especially the right ventricle/cor pulmonale). May be more responsive to inhaled pulmonary vasodilators.</td>
</tr>
</tbody>
</table>
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, higher driving pressures. High PEEP and proning is likely a critical aspect of management

- In addition, patients may transition from Phenotype L to Phenotype H, an important observation during care due to the change in strategy.

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 distress/need for vent is quick. (Wang, et. al; Zhou, et al.). Many reports of patients going from stable to crashing within hours, not days.

- 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:

- Evidence is consistently emerging to support aerosolized transmission risks at all times. This is supported also by rate of transmission.
- It is important to recognize that while we use the term *airborne* to refer to a certain diameter size (MMAD), indeed droplets can still become aerosolized and travel beyond 6-feet (encapsulated, avoiding evaporation) (JAMA)
- There is absolute evidence to support certain activities guaranteeing airborne transmission (see list below in this section), and these should be performed using airborne precautions (including N95 or higher mask), without exception. It is our belief that if adequate PPE is not available, those so-called aerosol-producing procedures simply cannot be performed in a safe manner.
Studies of "viral load" support that greatest risk is closest to the patient, and when performing aerosol-generating-procedures. Because of diffusion, that viral load decreases the further from the patient you are.

- In our thinking: if there is any increased risk, and certainly there seems to be, the higher level of protection should be strictly followed (N95 or above). While we understand PPE shortages are driving difficult decisions, for adequate healthcare provider protection, this is a necessity.

**Current Published Guidelines**

- Direct Care: Surgical mask, Gown, Gloves, Eye Protection (shield or goggles) for direct-care *(WHO; CDC; SCCM)*
- Aerosol-Producing Procedures: N-95 or above mask, Gown, Gloves, Eye Protection (shield or goggles) *(WHO; CDC; SCCM)*
- Some are recommending consideration for both airborne and droplet precautions, deferring to local standards *(AHA)*
- Healthcare workers exposed to coronavirus are now permitted to stay at work as long as they are asymptomatic, take daily temp, and wear a face mask *(CDC)*

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

**Preparation**

- **Personal Protective Equipment:** Airborne (a must!) + Contact = N95 or higher, gown, gloves, goggles/face shield
- Least # people possible in room, close door during intubation and for a period after (AHA, 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 lists sources for purchasing these supplies
- 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) (APSF)
- Oxygenating
  - Either NO bagging (use NRB to minimize aerosolization) OR Hepa/Viral filter in between Resuscitator Bag and Mask with GENTLE breaths only (AHA, ASPF; CTS, Wax & Christian; Sorbello, et. al, Cheung, Tran, et. al)
  - 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)
- **Expect no respiratory reserve** (due to hypoxemic respiratory failure): SpO2 may drop quickly during attempt (Meng, et. al)
- 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 using video laryngoscope** (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)

**Post-Intubation**

(distress, RR, P/F<150), intubation is recommended (Meng, et. al)
Airway Management

- Finger occlude ET tube as soon as it is placed and stylet 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.

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)
  - Consider using 2 "chux" pads, one on pt chest (pad side up), one over pt face (pad side down) - pad sides face each other.
  - 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. Used ET tube should end up in between chux pads.
  - 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 as tube is removed to minimize cough exposure (most recommend not using NC, consider NRB mask or Venturi mask)
  - Consider transitioning to nasal cannula as patient settles and stops coughing
- 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 Wean:** Some facilities report placing patients on Room Air, CPAP +5 instead of extubating with the goal of preventing unnecessary exposure/aerosolization risk.

• **Post-Mortem Extubation:** If patient dies prior to extubation, airborne and contact precautions still necessary, ENSURE VENTILATOR IS OFF BEFORE DISCONNECTING. Some recommend:
  - Turn off ventilator
  - Clamp endotracheal tube
  - Disconnect the ventilator and immediately cap it
  - Leave patient intubated, leave clamped, or consider immediately placing filter and cap on end of endotracheal tube

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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)
- If bagging at your facility, 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) - no evidence for over-inflating cuff

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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 limits as low as 88% reported (Wax &amp; Christian)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>92-96%</strong> SCCM (SCCM suggests low threshold of 92%, but recommends that threshold be no lower than 90%)</td>
<td></td>
</tr>
<tr>
<td><strong>90-96%</strong> WHO</td>
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<tr>
<td><strong>88-94%</strong> AHA</td>
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</tbody>
</table>
### Oxygenation

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td><strong>once stable</strong></td>
<td>&gt; 90%</td>
</tr>
<tr>
<td><strong>once stable, pregnant</strong></td>
<td>92-96%</td>
</tr>
<tr>
<td><strong>Pediatrics initially (severe distress, cyanosis)</strong></td>
<td>≥ 94%</td>
</tr>
<tr>
<td><strong>once stable</strong></td>
<td>≥ 90%</td>
</tr>
</tbody>
</table>
| **Adults with COPD**     | DO NOT WITHHOLD OXYGEN  
                          | Goal per normal (no less than 88%) |

**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*

**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.**

**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)**
- Must monitor closely: **if any indication of failure or instability, especially WOB: discontinue and intubate** *(Gattioni, et. al)*
  - GCS < 10
  - Increased vasopressor support
  - P/F < 200
Noninvasive Ventilation

- O2 should improve (not stay the same!) within about an hour

**Equipment Consideration**
- Use dual-limb circuits when possible (one limb is inspiratory, one expiratory)
- Mask interfaces should NOT contain a leak port (can't filter these, increase aerosolization). Instead, use either a dual-limb if possible with equipment, or consider using single-limb with a leak port - filter the port. Either way, an expiratory limb or "expiratory/leak port" is critical for patient to exhale.

**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. It has been shown that a surgical mask over the patient's mouth/nose/prongs will reduce aerosol dispersion, except, of course, where there are mask leaks (Leonard, et. al; Vapotherm)
- 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) - (CP), 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 (single-limb use circuit with a leak port - filter it; dual limb - filter expiratory side)
  - Use a higher EPAP if tolerated (much above 12 is difficult, but do not exceed 20 cmH2O due to high risk of gastric insufflation).
  - Maintain ΔP (IPAP-EPAP) for tidal volume around 6 mL/kg (Vimeo - Dr. Clum)
  - 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):
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

Strategies

There is some debate on appropriate vent strategies with the following all coming from reputable references:

- **Adapting NIV Equipment for Invasive Ventilation**
  - Video: adapting NIV (not basic CPAP machines - which provide no ventilation support, difficult to provide higher FIO2s) for Invasive Ventilation (AARC)
  - If single-limb NIV, ensure leak port is in circuit, not mask, and filter it.
  - Humidity is necessary - preferred is HMEF (HME + Filter together) - additional filters, etc. may increase mechanical deadspace
  - Note that VT and minute ventilation displayed on single-limb is inspiratory, not expiratory (we can't measure expiratory at a leak port).
  - Initial Settings (Hess at 6:15 mark)
    - IPAP 25
    - EPAP 12 (Note: driving pressure IPAP - EPAP is 13, adjust IPAP for 6 mL/kg IBW)
    - Mode: S/T or PC
    - Rate: 25/min
    - TI: 0.8 s
    - FIO2: 1.0
  - The majority of resources still recommend ARDSnet, lung-protective strategies with higher PEEP (assuming the patient is PEEP-responsive)

- **There is evidence to support maintaining the driving pressure (Pplat - PEEP) to under 12-15.** Driving pressure is a reflection of the functional size of lung and may be a predictor of mortality - above 15 is worrisome. Maintaining a lower driving pressure may help by minimizing over-distention and other complications. The bedside take-home? We should optimize PEEP and then titrate/drop our VT not necessarily to a mL/kg but by monitoring driving pressures (Amato, et. al; Loring, et. al, Brower)
  - TO CALCULATE: obtain Plateau Pressure, then subtract PEEP.

- Some reports indicate that while some patients fit criteria for ARDS, some (maybe most) do not. These patients are more consistent with a hypoxic vasoconstriction, with near-normal lung compliance but significantly low P/F ratios. (ATS, ESICM). In these patients higher PEEP may actually worsen V/Q matching and is thus relatively contraindicated. Prone positioning also may be of only limited benefit.

- Consider need to prevent spontaneous breathing due to high respiratory drive, large pleural pressure swings, which may worsen
Invasive Ventilation

l 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 Equipment

- For specific ventilator advice, consider PSRC (Pennsylvania Society) - including stockpile ventilators. Also see our resources at bottom of page.
- Equipment should be as closed-circuit as possible, HEPA or viral filters placed on any exhalation ports. Dual-limb circuits are preferred over single-limb. Some hospitals have come up with scavenger-system add-ons to minimize exposures.

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).

Special Note on APRV: For those using APRV, here is a great resource on APRV-TCAV Method

Tidal Volume

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
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](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7948845/)). Please see notes on phenotypes in disease section above. PEEP in non-ARDS may transmit to pleural pressures and have an exponential impact on (decreasing) cardiac output. There is evidence to support use of PEEP in patients with poor lung compliance, but the opposite is true if patients have good compliance (normal plateau pressure)

- 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.

- HME:
  - may result in more mucous plugging (be aware of need to instill saline and in-line suction)
  - Consider over heated-wire particularly with single-limb ventilators (Zhonghua, et. al)
  - Note that some HMEs may claim to be viral filters as well, but most do not

- Heated Wire:
  - may result in more condensate in tubing, AVOID breaking circuit to empty condensate (exposure risk), used closed-system trap if available.
  - may increase risk of aerosolization (heat + humidity)

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

Use a lung protective strategy with ABG management (permissive hypercapnia via pH management, lower PaO2 than normal)

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.

**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: [PaO2/FIO2 Ratio Calculator](#)

Weaning/Discontinuation

Expect extended time on ventilator - weaning is often slow

- 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)

- There is debate on when and if to trach patients at some point (due to exposure risks)
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)
- Some recommend proning if refractory hypoxemia (SpO2 < 90%) despite maximizing vent settings (ATS)
- 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)
- Some recommend d/c prone once patient is sustained in stable state (FiO2 needs, Pplat, ABG, P/F)

- **Airway in Prone**: Reports of lost airways (gravity, secretions), skin breakdown (facial edema). Consider:
  - Secure with cloth tape - video demo of that here (use 2 people to tape, change when patient supine)
  - Reinforce with "pink tape" (such as Hy-Tape), esp if issues with oral secretions
  - Some also recommend successful use of "Stabilock tube holder" and "COMFIT"
  - In one report, Hollister in prone was linked with breakdown requiring treatment (Gomaa and Branson)
  - Use an "omniflex" adaptor, if needed
  - No matter the method used (or device used), skin integrity should be monitored closely due to facial edema in prone (Gomaa and Branson)

- **CPR IN PRONE**: If no airway, turn supine. If airway, CPR in prone (unless no risk of exposure in flipping to supine). SEE CPR TOPIC, BELOW

- **Pregnant**: recommend use of lateral decubitis position (off-load inferior vena cava), 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 University
- Learning module on Proning from Osler
**Critical Care Strategies**

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**Other Feedback/Information**

- **Airway:** RT should always be present to prone or supine a patient - securing the airway and avoiding disconnect is absolutely critical.
  - Most people report performing the "swimming" method of proning - turn head side-to-side every 2 hrs (See Oliveira, et. al for photos/description of this).
  - 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 long-term (> 6 hours) ECMO for either respiratory failure or cardiopulmonary failure, especially when other options have all been trialed (FDA, ATS, 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

- **Sudden Deterioration**
  - Consider pneumothorax, more common with SARS. Consider use of ultrasound to r/o if portable CXR delayed. (Wax & Christian)

- **If O2 is below goal**
  - Prone patient
  - Optimize PEEP (is patient PEEP-responsive?) - if over-distension, PEEP may decrease oxygenation
  - Recruitment Maneuver
  - Deep Sedation or Paralytics (with sedation) if signs of vent-patient dyssynchrony
  - Inhaled Pulmonary Vasodilators (avoid iNO)
  - V/V ECMO

- **Pplat over 30**
  - Drop VT by 1 mL/kg IBW until at 4 mL/kg (do not go below 4)
  - Prone patient

- **Evidence of air-trapping** (flow not returning to baseline on graphics, measured auto-PEEP)
  - Check inspiratory time and I:E ratio, especially if using higher rates.
  - Consider dropping the set rate (which may actually improve pH/PaCO2 if air-trapping)
  - Signs of bronchospasm? Consider SABA

- **Risk Minimization Strategies**
  - Some recommend placing ventilator monitoring screen outside of room, requires 2 people to make changes while assessing patient, but may assist with basic monitoring
Some recommend positioning vent monitoring screen to be clearly visible from outside room, use of binoculars, zoomed phone screen, to avoid unnecessary risk in between scheduled room-time

Ventilator should be wiped down with approved chemicals at regular intervals

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**Bronchoscopy**

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

- Bronchoscopy in COVID+ is relatively contraindicated - use only if upper resp samples are negative and needed for significant clinical management (AABIP, IPC)
- Postpone all non-urgent bronchoscopies (AABIP, ACS)
- Sputum specimens should be obtained by closed suction with endotracheal tube with COVID sampling preference for lower respiratory tract (SCCM)
- If considering: minimize disconnections, use of bronchoscopy adapter on ET tube is recommended
- If considering: place mask on patient during bronch if not intubated (minimizes exposure)
- Use of disposable bronchoscope, if possible
- Minimal personnel (only essential people needed to perform bronch)
- For all samples sent to lab: be sure to alert lab to COVID-19 status
- Standard high-level disinfection for equipment

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**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)*

Do not induce for sputum collection (such as use of hypertonic) (AABIP)

**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)

(Except: diseases that produce abnormal secretions such as Cystic Fibrosis, Bronchiectasis, etc.)

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**Aerosol-Generating Procedures**, a common term in literature now, is covered in PPE section. Bottom line: Avoid whenever possible, but wear max PPE (airborne + Contact + Negative Pressure Room) if necessary.
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)**

Direct Link to the COVID-19 AHA new Algorithms (pg 14+)

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) (AHA)**
- 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
- Use mechanical CPR device if available, if pt meets height + weight criteria

**CPR for Non-Intubated Patients**

( may result in aerosolizing the virus, increasing risk)

- Initially, assess rhythm and defibrillate if ventricular dysrhythmia (AHA)
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, covered also with a surgical mask (AHA)

- 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
- Pause chest compressions to intubate - allow for more accurate intubation (less particle spread) (AHA)

CPR for Intubated Patients (or with artificial airway)

- **Consider leaving on ventilator during code to keep a closed circuit** and make the following changes (per AHA guidelines):
  - Mode: PC, A/C with target of 6 mL/kg IBW
  - FIO2: 1.0
  - Trigger: OFF
  - Set Rate: 10/min (adults, peds) or 30/min (neo)
  - Consider PEEP to optimize for venous return to heart
  - If/when ROSC is established, place on appropriate clinical settings

- **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 (AHA)

- **No Airway**: attempt to place in supine position for resuscitation
- **Artificial Airway**: avoid turning the patient to supine unless able to do so without risk of equipment disconnection
  - Place defibrillator pads in the A-P position
  - Provide CPR with pt remaining prone - over T7 and T10 vertebral bodies

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)
### Respiratory/Critical Drugs

- **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** *(mucokinetics 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**

- Consider early transfer of deteriorating patients to ICU *(Liew, et al.)*
- Medically-essential transport only *(CDC)*
- Inform receiving department of COVID+ patient beforehand *(CDC)*
- Transporting Team should wear PPE (some recommend all everything *(Liew, et al.)*), CDC recommends full PPE while handling the patient, but then only wearing a face mask during transport *(CDC)*
- Patient should wear surgical mask if not intubated *(CDC)*, do not transfer on HFNC, NPPV, etc. *(Liew, et al.)*. Cover patient with a clean sheet *(CDC)*
- Clean and disinfect all high-touch surfaces, including side rails, headboard, footboard, etc. *(NebraskaMed)*
- Routes should be designated (and dedicated, if possible) between departments to minimize contact with others. If team MUST pass through bystander area, it is advised to have security or someone who can safely clear the area prior to arriving. Any accompanying security should wear masks. *(Liew, et al.)*
- If intubated: use transport ventilator, if available. If no transport vent available, consider bagging (filters!) with PEEP valve
Recommended Resources

We are aware that there are many resources building out there. We are prioritizing what we see as the most useful resources. Please let us know if you think there's something that should be added.

Taking Care of Yourself - Helps for Managing Stress

Resources for Coping with the Pandemic

We understand that this is an incredibly stressful time. Coming face-to-face with death is part of what most of us do, and yet for the most part we receive no formal training or education on that. The stress of working without adequate supports ... without appropriate protections ... the feeling that you're unsupported on the battlefield and then shunned as a potential infectious source in the community ... the nagging worry of becoming or being COVID+ ... the lack of sleep. We don't need to list more - you're living it. We have no magical solutions, but we do want you to know that we are here. Truly here. We've been working to compile the best resources we can find to help you navigate these uncertain times.

- **Center for Study of Traumatic Stress** - Sustaining Your Well-Being (as a Healthcare Professional)
  Overall good tips - how many are you doing? Our favorite is to honor your service - you are taking care of those most in need. This is an INCREDIBLE calling that comes sometimes at an incredible cost. You really are amazing. I mean, really amazing.

- **Article: Micropractices (quick!) for Burnout Prevention and Emotional Wellness (COVID-19)**
  Micropractices are things you can do during a workshift to manage your well-being. Being intentional with your own wellness can be difficult to do when things are overwhelming, when you're being swallowed by everything happening. That's why it is all that much more important. Just like there are no emergencies in a disaster (we take the time to properly gear up, avoid exposures), there are no reasons not to apply micropractices to emotional well-being.

- **Private Facebook Group for PTSD Support**, specifically for RTs
  I personally know one of the people involved in coordinating this group, and I can tell you there is no one more compassionate than she in helping navigate this time. If you're on Facebook and this type of support is helpful to you, please consider checking it out. It is a private group for Respiratory Therapists.

- **The Schwartz Center Resources for Healthcare Professionals**

Clinical Information and Consensus Reports

- **American Association for Respiratory Care (AARC)**
  - AARC Video: How to use NIV for Invasive

- **American Heart Association Interim Guidance during COVID-19 Outbreak**
  - AHA Training Modules (developed with AARC/ASA)

- **Anesthesiology Special Section: COVID-19 (Intubation and Ventilation)**

- **Cardiac Evaluation/Consideration with COVID (American College of Cardiology)**

- **COVID ICU Bundle Checklist** (Brigham and Women's)
- **Centers for Disease Control**
  - Main Coronavirus Page
  - Guidelines for Optimizing PPE
  - Frequently Asked Questions about PPE

- **International Pulmonologists Consensus Report** (IPC)

- **Inhaled Nitric Oxide Clinical Trial Information** (clinicaltrials.gov)

- Protected Code Blue Review

- **PSRC/Tom Lamphere - page with info on specific equipment** (using V60 invasively, for example)

- **Safe Airway Society** (Australia, New Zealand)

- **Society of Critical Care Medicine**
  - Ventilator Strategies Card

- **Uptodate.com** Open Access Clinical Information for COVID-19 - well regarded evidence-based clinical site

**Algorithms Used in Management**
- COEMV Suggested Management Algorithms
- MGH Suggested Algorithm for Management
- SCCM COVID with Hypoxia Algorithm
- Alberta Health Services Guide

**Personal Protective Equipment**

**Centers for Disease Control (CDC)**
- Control Recommendations
- Frequently Asked Questions about PPE

**JCAHO Statement**: Face masks brought from home

**U.S. Dept of Labor (OSHA)** - see Healthcare Workers and Employers Section

**World Health Organization** - PPE Guidance for Healthcare Workers

**Yong, Ed. Everyone Thinks They're Right About Masks** (the Atlantic)
Great article for mainstream primarily but describes concerns well

**Citizens Against COVID-19**: A not-for-profit group working to fill PPE needs creatively. Currently offer an intubation enclosure. This is not FDA-approved, but it may be helpful in limiting exposure. Oh, and it is free.

**Simple Respiratory Mask Instructions** (Journal Article)
Links to Manufacturers/Info for COVID-specific information

Draeger Coronavirus Page
- PEEP trial for Draeger Apollo (Anesthesia machine) - video

Fisher & Paykel (AIRVO 2)

Getinge (Servo, etc.) Coronavirus Page

Hamilton Medical COVID-19 Updates

Philips Coronavirus Page
- Video: How to Use V60 for Invasive (NOT manufacturer video - Jimmy McKanna)

Percussionaire TXP5 Mass Casualty Ventilator (provides lung protection)
+ similar to IPV, very quick to connect, uses HFV/chest wiggle
+ no alarms currently, but ver. 2 will have adjustable alarms
+ can suction in-line

Vapotherm - COVID Resource center

Other Resources
- License to practice between states info
- AARC COVID TeleHealth Physician Letter to Surgeon General
- AARC Strategic National Stockpile Vent Training Program
- FDA News - Ventilator Production
- NEJM Article: The Toughest Triage - Allocating Ventilators in a Pandemic
- NEJM Article: Fair Allocation of Scarce Medical Resources in the Time of COVID-19
- National Board of Respiratory Care - COVID changes in testing/credentials
- Official AARC Statement Release on Multiple Patients on a Ventilator

Pride in What We Do - A Collection of Videos and Articles Highlighting RTs

Pride in What We Do
- NPR - Interview with Tom Barnes (Respiratory Therapy Instructor at Northeastern)
- UK RT Talks about Being on the Frontlines (WKYT)
- Respiratory Therapists More Valuable Than Ever Amidst COVID-19 (NewsWest9)
- NYC Hospital Worker (Respiratory Therapist) Returns to Treat Patients
- We Want to Make a Difference: Respiratory Therapists Among COVID-19 Heroes
- Coronavirus Patients Need More Ventilators and More Respiratory Therapists to Run
Local Respiratory Therapist Explains How Ventilators Work (Fox31)

Battle-Ready Attitude: Washington's Respiratory Therapists Help Fight War on COVID-19 (King5)

Respiratory Therapists are Key Figures in Fight Against Coronavirus (Boston 25)

Respiratory Therapists' Importance Highlighted in COVID-19 (KFOR)

We Need More Ventilators, But We Also Need People Who Run Them (Mother Jones)

Cuomo wants more ventilators, but are there enough specialists to run them? (Syracuse.com)

Armed with Breathing Machines, Respiratory Therapists Face Coronavirus on the Front Line (Mountain View Voice)

Retired Respiratory Therapists Coming Back to Work Amid Coronavirus Crisis (WTVD)

Honoring Respiratory Therapists Fighting COVID-19 (KNWA)

For Respiratory Therapists, Life Keeps Getting Busier (Norfolk Daily News)