Airway and Ventilator Management for Adult Patients who are Persons Under Investigation for or Known to have COVID-19 at Harbor-UCLA Medical Center (v10, updated 8/18/2020)

The following guidelines have been developed informed by the following:

- The Australian and New Zealand Intensive Care Society (ANZICS) COVID-19 Guidelines Version 2[i]
- Brown C, et al. Pragmatic Recommendations for Intubating Critically Ill Patients with Suspected COVID-19. JACEP Open.[ii]
- Surviving Sepsis Campaign: guidelines on the management of critically ill adults with Coronavirus Disease 2019 (COVID-19)[iii]
- Consensus statement: Safe Airway Society principles of airway management and tracheal intubation specific to the COVID-19 adult patient group[iv]
- Input from representatives from Harbor-UCLA Medical Center Department of Emergency Medicine, Division of Pulmonary and Critical Care Medicine, Division of Surgical Critical Care, Department of Anesthesia[v]

Avoidance of Unnecessary Aerosol-Generating Procedures (AGPs)

Transmission of COVID-19 is thought to be primarily via droplet spread unless an AGP is performed.[vi] AGPs increase the risk of transmission of COVID-19 to others, including healthcare workers. The following are generally considered to be AGPs:

- Cardiopulmonary resuscitation
- Non-invasive positive pressure ventilation (CPAP, BiPAP, Bag-Valve Mask ventilation)
- High flow nasal cannula (HFNC) or regular nasal cannula with flow ≥ 6 L/min
- Nebulized or atomized medications
- Tracheal suction in absence of a closed system
- Tracheal extubation

The following are vulnerable to aerosolization:

- Laryngoscopy
- Tracheal intubation
- Bronchoscopy
- Front of neck airway (tracheostomy, cricothyroidotomy)

Whenever a necessary AGP is performed, the patient should be in a negative pressure isolation room with all health care workers in the room in PPE for airborne and contact precautions.

Use of Non-Invasive Positive Pressure Ventilation and High Flow Nasal Cannula (HFNC) Therapy

Experience in other countries with SARS-CoV-2 and with SARS-CoV-1 demonstrate that CPAP and BiPAP (1) have relatively high failure rates, and (2) are aerosolizing procedures which potentially exposes others to risk. The benefit of these modalities is uncertain in the absence of an alternative diagnosis that would benefit from CPAP or BiPAP (e.g., CHF, COPD). If HFNC is unavailable, CPAP and BiPAP can be considered for milder illness but should be very closely monitored for early deterioration and patients in a negative pressure isolation room with airborne/contact precautions.[vii]

HFNC appears to aerosolize fewer particles, but airborne and contact precautions are required. Patients with nasal prongs should wear a surgical mask to prevent droplet spread via the mouth. In patients who do not have severe disease, HFNC is a modality of respiratory support that should be trialed prior to considering endotracheal intubation. HFNC requires two settings: flow and FiO_2. Start the flow at 30-40L/minute and titrate this to the patient's work of breathing. Higher flow rates likely cause higher rates of aerosolization and higher complication rates but can increase to 60L/minute as necessary. FiO_2 can be started at 100% but should be titrated at bedside prior to leaving the room to the patient's goal SpO_2.

In general, patients who require ≥40L/minute of flow or ≥60% FiO2 should be considered for MICU consultation/admission, whereas patients with lower HFNC settings may be PCU appropriate. When patients no longer have substantial requirements (≤30L/minute flow and ≤40% FiO_2), they may no longer require HFNC.

Predictors of HFNC Success

In patients who do not require immediate endotracheal intubation but require respiratory support, close monitoring for success or failure on HFNC should be undertaken. The ROX index has been proposed as a tool to determine success or failure in HFNC. This has been prospectively validated in patients with pneumonia, but has **not** been validated in patients with COVID-19. The index is calculated by: ROX Index = (SpO_2/FiO_2)/RR. Lower scores (meaning higher respiratory rates and/or a lower SpO_2/FiO_2 ratio) are associated with higher intubation rates in patients with pneumonia.

- ROX Index ≥4.88 measured at 2, 6, or 12 hours after high-flow nasal cannula (HFNC) initiation is associated with a lower risk for intubation
- ROX Index <3.85, risk of HFNC failure is high, and intubating the patient should be considered
- ROX Index 3.85 to <4.88, the scoring could be repeated one or two hours later for further evaluation

As more data are available, this may be an appropriate scoring system in the future. Currently, we are working implementation the ROX score into ORCHID as a data gathering tool, but not necessarily as part of decisions to intubate or admission level of care.

Patients who are failing HFNC are unlikely to succeed on BiPAP/CPAP and should be endotracheally intubated if this is in line with their goals of care.

Location of Intubation and PPE

When possible, endotracheal intubation (ETI) should be completed in a negative pressure isolation room, using airborne and isolation precautions. Stable patients that require ETI should be moved to a negative pressure isolation room prior to the procedure. To safely transport patients prior to intubation, a surgical / procedure mask should be applied to the patient over the nasal cannula, HFNC, or nonrebreather mask, and staff should wear airborne PPE.

Unstable patients need to have the risks of delay in airway management with transfer weighed with the benefits of ETI in a safer setting, for both the patient, health care workers, and other patients in the area. If a negative pressure room is unavailable, a single patient room should be used for intubation, using airborne and contact precautions.

Staff present in the room should be minimized to only essential individuals. Precautions should include:

- Fit-checked N95 mask, PAPR, or CAPR
- Goggles or face shield (if N95 is used)
- Gown
- Gloves

If an intubation must be considered outside of a negative pressure isolation room, providers may consider adjuncts such as a plexiglass box or additional draping. However, there are no data to suggest these are effective and it has been shown to increase the difficulty of ETI.[viii]

General Considerations for Endotracheal Intubation (ETI)

- Early HFNC should be considered prior to ETI in patients with COVID-19. Patients should be rechecked frequently and a decision to perform ETI should be made once it is expected that the patient will fail HFNC. This will allow for ETI in a more controlled setting.
- The fewest number of people possible should be in the room. In general, this minimum team would be (1) one nurse, (2) one respiratory therapist, and (3) the most experienced provider available to perform the intubation. More individuals may be required in specific clinical circumstances, but this increases the risk of exposure and secondary transmission. A second individual experienced in intubation should be immediately available outside the room in appropriate PPE for immediate intervention, if required.
- If the provider performing the intubation is a trainee, a supervisor may be present in the room or outside the room in full PPE and immediately available to intervene, if necessary, at the discretion of the department and/or supervisor. Individual departments may decide what level, if any, of trainee is appropriate to provide management to these patients, but trainees may opt out of performing airway management on these patients.
- Video laryngoscopy with a screen separate from the insertion blade is the preferred modality for ETI to prevent exposure to others when performing intubation on a PUI or COVID(+) patient. Due to the need to preserve video laryngoscopy supplies for COVID patients, direct laryngoscopy should be used when COVID is not suspected.
- Rapid sequence intubation (RSI) should be performed with an induction agent and an appropriate neuromuscular blockade agent. Unless clinician preference or clinical circumstance dictates, high dose (1 to 1.2 mg/kg ideal body weight) rocuronium is the paralytic generally preferred in this situation, as higher doses of rocuronium still allow for rapid onset and no risk of the neuromuscular blockade wearing off before a closed ventilator system with an inflated endotracheal tube cuff in the trachea is established. Awake intubation should be performed only when absolutely necessary.
- If first pass success of ETI is not achieved, consider a supraglottic device (such as a laryngeal mask airway [LMA]) as an oxygenation and ventilation strategy to reduce aerosolization compared with BVM.
- Disposable items are preferred over reusable equipment whenever possible.

Preoxygenation and utilization of BVM during RSI

- For patients failing HFNC who require ETI there are two options depending on the clinical circumstance:
    1. Keep the HFNC on during intubation and set FiO_2 to 100% if not already done. This is an aerosol-generating procedure and all individuals should be in a negative pressure isolation

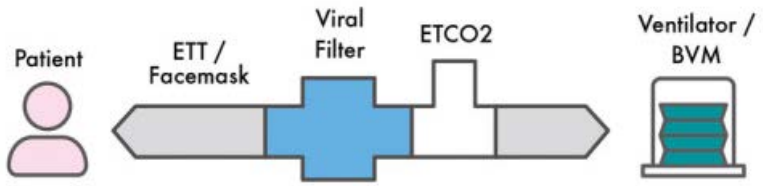
room with appropriate PPE. Turn off the HFNC immediately prior to inserting the laryngoscope, as keeping the high flow on during laryngoscopy will cause aerosolization.

2. Remove HFNC and use a BVM with attached viral filter and with waveform capnography. If the seal achieved is not perfect, this is an aerosol-generating procedure.

- Apneic oxygenation is an AGP with the aerosolization directly proportional to the flow chosen. If using apneic oxygenation, use the lowest flow necessary to achieve safe oxygenation targets.
- Utilize a checklist (attached) to ensure adherence to best practice guidelines.
- After inflation of the endotracheal tube cuff, attach the patient directly to ventilator without BVM if possible.
- Minimize ventilator disconnects and, if necessary to disconnect, utilize an ET tube clamp at the end of expiration to maintain PEEP and minimize aerosolization.

Bag Valve Mask Considerations

- A BVM, when utilized, should have a viral filter and a two-handed mask seal and smaller tidal volumes to allow for appropriate seal maintenance and prevent aerosolization.
- Some BVM will have pre-attached viral filters. If pre-attached, do not need to relocate. Otherwise, set up the BVM with the viral filter as close to the face mask as possible in the following fashion:



- A BVM should, if available, have waveform capnography to ensure appropriate ventilation with a good seal. A triangular rather than square capnograph or low absolute numbers suggest leaking and should prompt for assessment of patency of seal.

Post-Intubation

Routine paralysis post ETI should not be implemented unless required for patient-ventilator synchrony despite appropriate analgosedation in the appropriate clinical context (2019, ROSE trial). Post-intubation sedation should be in the room during the ETI of the patient and immediately started. The preferred ICU analgosedation agents are fentanyl and propofol but this may require modification based on clinical context and anticipated drug shortages.

Post-intubation chest X-rays should be delayed until after NG/OG and central line insertion if this is a planned procedure post intubation and the patient has appropriate oxygen saturation and waveform capnography. This will minimize the number of entries into the room.

Consider immediate availability of vasopressors (norepinephrine preferred) to mitigate or manage post-intubation hypotension.

PPE should be removed with a “spotter” and disposed of properly.

Initial Ventilator Management Strategy

Patients intubated with COVID-19 are at high risk of ARDS (or have ARDS already) and so initial ventilator management in adult patients should be:

- Volume assist-controlled ventilation such as pressure-regulated volume control (PRVC)
- Tidal volumes 6-8 mL/kg of predicted body weight (PBW) for height
- Titrate PEEP and FiO_2 for a target SpO2 of no greater than 96% (range 92-96%)

Predicted Body Weight and Tidal Volume (in mL) for **Females**						
Height (in)	PBW (kg)	4 mL/kg TV	5 mL/kg TV	6 mL/kg TV	7 mL/kg TV	8 mL/kg TV
5’ 0” (60)	45.5	182	228	273	319	364
5’ 1” (61)	47.8	191	239	287	335	382
5’ 2” (62)	50.1	200	251	301	351	401
5’ 3” (63)	52.4	210	262	314	367	419
5’ 4” (64)	54.7	219	274	328	383	438
5’ 5” (65)	57	228	285	342	399	456
5’ 6” (66)	59.3	237	297	356	415	474
5’ 7” (67)	61.6	246	308	370	431	497
5’ 8” (68)	63.9	256	320	383	447	511
5’ 9” (69)	66.2	265	331	397	463	530
5’ 10” (70)	68.5	274	343	411	480	548
5’ 11” (71)	70.8	283	354	425	496	566
6’ 0” (72)	73.1	292	366	439	512	585
6’ 1” (73)	75.4	302	377	452	528	603
6’ 2” (74)	77.7	311	389	466	544	622

Table 1: Predicted body weight for females of various heights and associated tidal volumes.

Predicted Body Weight and Tidal Volume (in mL) for **Males**						
Height (in)	PBW (kg)	4 mL/kg TV	5 mL/kg TV	6 mL/kg TV	7 mL/kg TV	8 mL/kg TV
5’ 0” (60)	50	200	250	300	350	400
5’ 1” (61)	52.3	209	262	314	366	418
5’ 2” (62)	54.6	218	273	328	382	437
5’ 3” (63)	56.9	228	285	341	398	455
5’ 4” (64)	59.2	237	296	355	414	474
5’ 5” (65)	61.5	246	308	369	431	492
5’ 6” (66)	63.8	255	319	383	447	510
5’ 7” (67)	66.1	264	331	397	463	529
5’ 8” (68)	68.4	274	342	410	479	547
5’ 9” (69)	70.7	283	354	424	495	566
5’ 10” (70)	73	292	365	438	511	584
5’ 11” (71)	75.3	301	377	452	527	602
6’ 0” (72)	77.6	310	388	466	543	621
6’ 1” (73)	79.9	320	400	479	559	639
6’ 2” (74)	82.2	329	411	493	575	658

Table 2: Predicted body weight for males of various heights and associated tidal volumes.

FiO_2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
PEEP	12-14	14-16	18	18-20	18-20	22	22	22-24

Table 3: Trial FiO_2/PEEP Protocol

Target plateau pressures should be < 30 cm H_2O. If initial TV is set a 6 mL/kg and the measured Pplat is persistently over 30 cm H_2O, reduce the TV by 1 mL/kg as tolerated to a minimum of 4 mL/kg PBW until Pplat is within range.

Barotrauma is common and vigilance for pneumothoraces should be maintained. Fluid restricted management is recommended and early norepinephrine should be instituted for hypotension.

The appropriate PEEP to use is currently unknown. Guidelines have a weak recommendation for the usage of a higher PEEP strategy (Table 3), although others have found that many patients requiring intubation due to COVID-19 have relatively high lung compliance. It is reasonable to set the initial FiO_2 and PEEP as per the table above to target appropriate oxygenation and seek expert consultation for subsequent management.

Management of Severe ARDS

If a high-PEEP volume assist-control strategy is insufficient in providing appropriate oxygenation, prone positioning should be performed if feasible. Prior to prone positioning, strong consideration should be given to placement of central venous catheter placement and arterial line placement, as these procedures are (1) substantially more difficult after prone positioning, and (2) prone positioning is associated with loss of established vascular access.

Instructions on prone positioning: https://www.youtube.com/watch?v=E_6jT9R7WJs

If prone positioning is not feasible, airway pressure release ventilation (APRV) is potentially a valuable rescue mode. If APRV is a ventilator mode less familiar to the clinician, seek expert consultation. V-V ECMO should not be considered prior to optimizing patient positioning and ventilator management (2018, ELOIA trial). It unlikely that we will have resources to provide V-V ECMO outside of very highly selected patients and multidisciplinary discussion. If optimal ventilator management fails, contact the trauma service attending on call to consider V-V ECMO. Outside of expert consultation, high frequency oscillatory ventilation (HFOV) should not be utilized in ARDS patients (OSCILLATE, OSCAR trials).

Multiple Patients on One Ventilator

Multiple patients should almost never be put on a single ventilator. This is consistent with the consensus statement issued by the Society of Critical Care Medicine (SCCM), American Association for Respiratory Care (AARC), American Society of Anesthesiologists (ASA), Anesthesia Patient Safety Foundation (APSF), American Association of Critical-Care Nurses (AACN), and American College of Chest Physicians (CHEST).

Therapy and Testing for Patients in the Emergency Department on Respiratory Support

If on oxygen, HFNC, or intubated, give dexamethasone 6 mg (IV or PO) in the Emergency Department unless contraindications to corticosteroids make the drawbacks outweigh the benefits. Obtain basic labs including liver function testing to allow the inpatient team to start remdesivir. Because remdesivir requires consent and authorization from pulmonary critical care medicine or the immunocompromised service, in general do not need to start remdesivir in the ED.

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Harbor-UCLA HCCC Protected Airway Checklist v5

Pre-procedural Huddle (Outside of patient room)	
Introductions	
SBAR	
Patient weight, IV access, allergies	
Determine that patient meets criteria for intubation	
Discuss need for additional procedures (CVC, A-line, Foley) and attain necessary equipment	
Preparation (Outside of patient room)	
PPE check completed (Donning with Coaching) *checklist	
Intubating MD, RN, and RCP double gloved	
Attain intubation medications and post-intubation sedation medications	
Visually confirm airway/ventilation equipment in room: • Oxygen regulator • Suction regulator • Capnography module on monitor	
Supplies Check: • Airway supplies: video laryngoscope, direct laryngoscope, endotracheal tube, stylet, 10mL syringe, AnchorFast • Suction cannister, tubing, and Yankauer tip (if not present in room) • Rescue Supplies: laryngeal mask airway, 60 mL Syringe, bougie • IV start kit, IV catheter, 6-10 NS Flushes • Shoulder roll • Waveform capnography line or color change device (if waveform not available) • BVM • HEPA viral filter • Central line equipment and NS flushes (if central line indicated)	
Equipment check: • Video laryngoscopy (confirm battery powered) with disposable stylet • Alaris pump for post-intubation sedation and/or appropriate length extension sets • Ventilator (check function) and appropriate length circuit • Communication device: baby monitor, phones, white board/marker, etc. • Ultrasound (if central line to be placed) and probe cover	
Preparation (Inside of patient room)	
Attach and initialize waveform capnography to ventilator	
Confirm IV is functioning; replace if necessary	
Optimize patient positioning	
Close all carts in room to prevent contamination with aerosolized particles	
Pre-Oxygenation	
Apply non-rebreather mask (15 L) if not already in place	
BVM only with viral filter in place and two-person technique	
Avoid CPAP/BiPAP if preoxygenation can be safely achieved otherwise	
Intubation	

Consider apneic oxygenation at ≤ 5 L/min if adequate oxygenation achieved prior to medication administration. Higher concentration if inadequate pre-oxygenation.	
Attach ETT with inflated cuff directly to ventilator if possible	
Minimize disconnects	
Post-intubation	
Secure ETT with AnchorFast device	
Insert NG/OG tube (to be performed by physician at head of bed)	
Obtain tracheal aspirate sample if COVID-19 status unknown	
Portable CXR – consider delaying if NG/OG or central line will be placed	
Physician and/or RCP should remain in room until CXR reviewed in case ETT requires replacement/adjustment.	
Place central line (IJ preferred) if indicated	
Appropriate Doffing with Coach *using checklist	
Debrief	
Appropriate and Safe Handling/Disinfecting of Equipment	

[i] https://www.anzics.com.au/wp-content/uploads/2020/04/ANZI_3367_Guidelines_V2.pdf
Updated 4/15/2020, accessed 7/29/2020
[ii] https://onlinelibrary.wiley.com/doi/10.1002/emp2.12063
Updated 3/25/2020, accessed 7/29/2020
[iii] https://link.springer.com/article/10.1007/s00134-020-06022-5
Updated 3/28/2020, accessed 7/29/2020
[iv] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7267410/
Updated 6/2020, accessed 7/29/2020
[v] Most recent consensus 7/16/2020
[vi] https://www.cdc.gov/coronavirus/2019-ncov/hcp/non-us-settings/overview/index.html
Updated 6/8/2020, accessed 7/29/2020
[vii] https://www.covid19treatmentguidelines.nih.gov/critical-care/oxygenation-and-ventilation/
Updated 7/17/2020, accessed 7/29/2020
[viii] https://onlinelibrary.wiley.com/doi/full/10.1111/anae.15115