

SPECIAL CONTRIBUTION

Infectious Disease

Pragmatic recommendations for intubating critically ill patients with suspected COVID-19

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1 | INTRODUCTION

As the novel coronavirus (COVID-19) spreads across the world, teams must develop airway management strategies that protect both patients and staff. While the fatality rate for COVID-19 is not clear, early data suggest that it is likely between 2% and 4%.^{1,2} The case fatality rates with Severe Acute Respiratory Syndrome (SARS) and Middle East Respiratory Syndrome (MERS) were 9.6% and 34.4%, respectively.³ While not as lethal proportionally, COVID-19 has resulted in more deaths worldwide, a fact which speaks to its communicability and the need for protective strategies when caring for infected patients. Transmission to healthcare workers is inevitable and more than 3000 cases have been reported so far.³ Thoughtful preparation will protect healthcare teams as they strive to care for those who are highly infectious.

Basic airway management principles apply to known or suspected COVID-19 patients, as they do with others who are critically ill. There are unique considerations with airway management under airborne precautions, however, and modifications to the standard approach are essential to minimize viral spread to care providers, particularly during aerosolizing procedures like endotracheal intubation. While our collective experience is rapidly evolving, the evidence basis for many

aspects of airway management in these conditions is limited. To aid care providers in optimizing the safety of patients and staff, we present pragmatic, multidisciplinary recommendations for airway management in these patients.

There are 3 key principles that should be priorities during airway management. These principles are aimed at minimizing staff contamination, mitigating viral spread, and reducing the risk of critical decompensation during intubation.⁴⁻⁶

1. Minimize aerosolizing the virus
2. Maximize first-attempt intubation success
3. Reduce personnel exposure

2 | MINIMIZE AEROSOLIZING THE VIRUS

Patient coughing, nebulization of medications, manual bag-mask-ventilation, and use of high-flow oxygen can all produce airborne droplets containing viral particles. Whenever possible, the following steps should be taken to limit viral spread during airway management.

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2.1 | Administration of medical therapy

Patients who arrive in respiratory distress may initially receive medical therapy. If truly necessary, patients with a potential highly infectious viral illness should have albuterol, ipratropium, and other respiratory medications administered by metered dose inhalers (MDIs) instead of nebulization.

2.2 | Early tracheal intubation

In patients who have developing respiratory failure requiring oxygenation and ventilatory support, early tracheal intubation is recommended instead of trials of noninvasive positive pressure ventilation (NIPPV) or high-flow nasal oxygen (HFNO). HFNO and NIPPV both risk aerosolization of upper airway droplets that contain viral particles. Prior SARS experience revealed that more than 90% of patients initially managed with NIPPV failed this approach and required endotracheal intubation.⁷ Given the high risk of failure of noninvasive respiratory support and the risk of aerosolization of viral particles, we advocate for early intubation in COVID-19 patients with respiratory failure. Early intubation should be considered in these patients if any of the following are present: Persistent tachypnea (RR > 25), marginal oxygen saturations (90-92%) despite supplemental oxygenation, bilateral infiltrates on chest imaging, sepsis physiology, or a trajectory of increasing respiratory distress despite medical management.

2.3 | Intubation setting

Aerosolization of viral-containing droplets may happen during intubation and spread can occur to personnel or nearby patients. Whenever possible, intubation should take place in a negative pressure room. Optimally, a dedicated negative-pressure "airway procedure room" should be identified in the emergency department (ED) and other care locations in which most, if not all, intubations would take place. The door to the patient room should remain closed as much as possible and bedside care clustered in order to minimize entries and exits. Negative pressure rooms may not be available at all times in the ED. Although mitigating viral spread is always crucial, intubating in a standard air-flow room requires heightened attention to reducing aerosolization (Table 1).

2.4 | Differences in intubation technique

Patients with COVID-19 will be intubated for current or expected hypoxemic respiratory failure and thus there is a delicate balance between the risk of rapid desaturation with induction and the risk of aerosolizing viral particles. As a result, and based on what we know about COVID-19, usual methods of preoxygenation in high-risk hypoxemic patients require modification. Ambient pressure preoxygenation with a tight-fitted facemask should be initiated as the default method

TABLE 1 Key considerations for airway management outside of a negative pressure room

Airway management step	Recommendation ^a
Oxygenation	Avoid high-flow pre-oxygenation. Use NIPPV with a tight-fitted mask for escalating preoxygenation. Avoid nasal cannula for apneic oxygenation.
Intubation	Avoid "closely intubating" with direct laryngoscopy. Use VL for indirect tracheal tube placement. Use RSI with the highest recommended dose of an NMBA.
Rescue techniques	SGA placement attached to closed ventilator circuit for rescue oxygenation in lieu of manual bagging. Use HEPA filters whenever PPV is performed.
Personal protective equipment	PAPR use preferred over N95, if available consider plastic face tent or hood.

HEPA, high-efficiency particulate air; NMBA, neuromuscular blocking agent; NIPPV, noninvasive positive pressure ventilation; PAPR, powered air purifying respirator; PPV, positive pressure ventilation; RSI, rapid sequence intubation; SGA, supraglottic airway; VL, video laryngoscopy.

^aRecommendations should be weighed against resource availability and clinical necessity.

in low-risk patients. Manual bag-assist or positive pressure ventilation (PPV), although not absolutely contraindicated, should be used only if clinically required. If bag-assist is needed, it should be performed as a 2-person procedure with a 2-handed (thenar grip) mask hold. This will improve mask seal and limit leak around the margins of the mask.⁸

In the ED, rapid sequence intubation (RSI) is the most common approach for airway management.⁹ In patients with COVID-19, RSI remains the preferred approach as the induction agent and neuromuscular blocking agent (NMBA) act synergistically for rapid-onset apnea and elimination of the cough reflex. During RSI, higher-dose NMBAs should be used (1.5 mg/kg IV of rocuronium or 2.0 mg/kg IV of succinylcholine) in order to prevent incomplete or slow-onset paralysis. After drug administration, it is imperative to allow the NMBA to take full effect (45-60 seconds) before starting laryngoscopy to eliminate the possibility of a patient reaction, coughing or regurgitation. Awake intubation techniques should be used *only* when absolutely necessary because of the risk coughing during the procedure.

High-efficiency particulate air (HEPA) filters should be placed in-line when PPV is being performed. Depending on the mode of ventilation, they should be placed *between*:

1. The bag-valve and inflatable mask or endotracheal tube (ETT).
2. The NIPPV machine and the mask (as close to the mask as possible).
3. The ETT and the Y-connector of a ventilator.

After tracheal tube placement, the ETT balloon should be inflated immediately and cuff pressure should be checked before the

bag-valve is attached or tube confirmation occurs. During ongoing patient care, providers should communicate closely with respiratory therapists to limit ventilator checks and disconnects. To avoid confusion, each provider should verbalize their actions and have those actions confirmed and acknowledged by the rest of the team. If a disconnect is required (ie, a transition from a room to a portable ventilator) this should be done at *end-expiration*. Consider temporarily placing a smooth clamp on the ETT at *end-expiration* before disconnecting to further avoid expelling viral particles, and to avoid loss of positive end-expiratory pressure leading to de-recruitment of alveoli.

3 | MAXIMIZE FIRST-ATTEMPT INTUBATION SUCCESS

First-attempt success reduces peri-intubation adverse events.¹⁰ Steps implemented to augment first-attempt success are paramount. For patients with COVID-19, the main goals are to minimize the need for interposed bag-mask ventilation and to reduce the risk of hypoxic complications.

3.1 | Communication

We recommend that each airway team develop and use a checklist to ensure compliance with protective steps. Additionally, team leaders should clearly delineate roles and the airway management plan using closed-loop communication with verbal confirmation by team members.

3.2 | Preoxygenation

Providers should optimize preoxygenation, maximizing time for a successful first-attempt. Intubating hypoxemic patients who will further desaturate rapidly after RSI meds are administered places them at risk of critical hypoxemia or death during the procedure.¹¹ The optimal preoxygenation strategy is not clear, and the risk of desaturation needs to be weighed against the availability of equipment, resources, and the potential for viral spread.

We recommend 3–5 minutes of tidal volume breathing of 100% oxygen on a tightly fitted nonrebreathing (NRB) mask at 15 L/min of flow and upright patient positioning. If the patient remains hypoxemic (<93%), modified positive pressure preoxygenation should be performed, if available. This can be accomplished by using a tight-fitting NIPPV mask connected to an in-line HEPA filter and a closed dual-limb ventilator circuit. Providers may need to hold the mask in place to ensure a tight seal. Continue positive pressure preoxygenation until the patient is apneic, then *suspend* the ventilator before removing the mask to prevent aerosolization. Consistent mask fit is important to both increase the quality of preoxygenation and reduce the degree of leak. Patients who are unable to effectively preoxygenate because of

aggressive or agitated behavior may benefit from ketamine or haldol in order to induce compliance with preoxygenation efforts.

If NIPPV is *unavailable*, higher oxygen flow rates may be necessary to optimize preoxygenation. The use of high flow or “flush-flow” rate oxygen delivery might result in excess flow that could spill out around the edge of the mask carrying viral particles. Although high-flow oxygen delivery methods are not routinely recommended, maximal preoxygenation and patient safety may outweigh the risk of aerosolization and contamination in some patients. Judicious escalation of oxygen flow rates, optimally with a tightly fitted or cuffed mask, can be done when resource limitations prevent access to NIPPV and the patient has persistent hypoxemia (<93%) despite initial efforts.

If high flow or positive pressure methods of preoxygenation are used, it is imperative that the intubation takes place in a negative pressure room. Additionally, a clear plastic face tent or hood can be placed over the patient’s head, if available, and the entire team must pay extreme attention to effective personal protective equipment (PPE). If a negative pressure isolation room is not available, high oxygen flow rates should be avoided.

Once RSI medications are administered, rapid desaturation may begin as soon as the patient is apneic. The speed which this happens, depends on the effectiveness of preoxygenation and the severity of air-space disease. Traditional teaching has been that an intubation attempt should be aborted when the saturation falls below 93%. Since this may happen quickly in patients with COVID-induced acute respiratory distress syndrome, clinicians should prepare for and tolerate, during laryngoscopy, *brief* periods of oxygen saturations less than 90% if that brief period allows successful tube placement and obviates the need for rescue bag-mask ventilation.

3.3 | Personnel and equipment

The most experienced available clinician should intubate. We *strongly* recommend the routine use of video laryngoscopy as it improves first-attempt success.⁹ A video (indirect) view should be used for tracheal tube placement. We recommend a bougie-first intubation technique to further increase first-attempt intubation success when standard geometry video laryngoscopy is used.¹² Ensure that each attempt is optimized with thorough preoxygenation, use of RSI, proper patient positioning and augmentation maneuvers, as needed, such as external laryngeal manipulation. Clinicians should have all required airway equipment (endotracheal tubes, in-line suctioning, bougie, supraglottic airway (SGA) device, syringe, lubricant, ET_{CO}₂, VL with multiple blade sizes/shapes, single-use Macintosh/Miller set-up, cricothyrotomy kit) at the bedside. Disposable equipment should be used as much as possible to avoid the risk of viral exposure after use.

If the initial intubation attempt is unsuccessful, consider immediate placement of a SGA, fit with a HEPA filter, connected directly to a ventilator. A SGA that could facilitate intubation through the device would be preferred. This approach will allow for oxygenation and ventilation while avoiding manual bagging and aerosolizing viral particles in between attempts. If rescue mask ventilation is performed, it should

be a 2-person procedure. The most experienced operator should hold the mask using a thenar grip technique with an oral airway in place. We recommend a *low volume* bagging approach.

4 | REDUCE PERSONNEL EXPOSURE

4.1 | Personal protective equipment

The Centers for Disease Control and Prevention (CDC) guidelines state that if aerosolizing procedures are planned for a patient with COVID-19, enhanced respiratory PPE is mandatory.¹³ This includes:

1. Bonnet
2. N95 mask or powered air purifying respirator (PAPR)
3. Eye protection and face shield
4. Gown
5. Gloves—using as double glove technique

Although not considered PPE, application of a clear plastic face tent or hood to help reduce aerosolization and cross-contamination, especially during preoxygenation, should be considered. It is imperative that providers follow institutional donning and doffing procedures with observer-ensured compliance. Only clinicians who have completed PPE training should intubate.

4.2 | Personnel and intubation equipment

We recommend a 3-person intubation team to include a nurse, respiratory therapist, and intubating clinician. During the SARS outbreak, cross contamination was highest when >3 providers were in the room.¹⁴ Ideally, a second airway manager should be donned outside the room and ready to assist immediately if needed. After the procedure, adhere to coached doffing steps including hand hygiene. Providers should not touch their face until this has occurred. We encourage formal team debriefing following all intubations.

Video laryngoscopy allows better intubator-to-patient distancing and the ability for indirect visualization of tracheal tube placement. Using the video screen for visualization obviates the need to get close to or look through the patient's mouth to intubate. All disposable airway equipment should be placed in a sealed biohazard bag after the intubation. Supporting equipment that is considered contaminated because of patient proximity (VL screen and stand, etc) should be disinfected with alcohol-based cleaning wipes.

Optimally, all protective measures would be used with each intubation; however, for clinicians in resource-strapped locations, out-of-hospital providers who may be working in austere environments, or at times when a patient is in extremis and the need for intubation is immediate, this may not be possible. In these circumstances, the following should be considered a list of minimal "must dos" to intubate patients with COVID-19.

1. Wear respiratory precaution PPE including an N95 mask or PAPR.
2. Preoxygenate with 100% oxygen and a tight-fitted mask.
3. Intubate with RSI, high-dose NMBAs, and video laryngoscopy.
4. Consider use of a supraglottic airway instead of manual bagging for rescue oxygenation.
5. Limit the number of bedside clinicians and doff all PPE safely including hand hygiene.

5 | CONCLUSION

ED airway management will be inevitable in many patients with COVID-19 and safety of both patients and providers is essential. Information is evolving quickly and these recommendations are meant to serve as a framework to safely intubate the critically ill patient with COVID-19.

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