

# COVID -19 Challenges

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## Introduction

COVID-19 is a newly recognised viral infection which first appeared in Wuhan, China in late 2019. It is caused by a novel Coronavirus, Severe Acute Respiratory Syndrome-CoronaVirus-2. For the most part it results in a mild, self-limiting flu-like illness but unfortunately, severe type one respiratory failure complicates between 14-17% of confirmed cases (Huang 2020; Chen 2020). At present, there is neither a proven specific anti-viral treatment nor a vaccine. Management is largely supportive. It is spread principally in droplets from the upper respiratory tract and fomite (surface-contact) transmission, but crucially, also by the kinds of aerosols generated during airway management procedures (Wang 2020; Van Doremalen

# Tracheal Intubation in the ICU During the COVID-19 Emergency

Making tracheal intubation safe for both patients and their health care providers.

2020). Consequently, airway operators are particularly vulnerable to contracting COVID-19 (Wax 2020). This article discusses how tracheal intubation is best performed in these patients using techniques which are safe for both patients and their health care providers. We do not address ethical considerations arising during an overwhelming pandemic. This article references the open access UK and Australian guidelines for airway management in COVID-19 patients (Cook 2020; Brewster 2020) and we commend these to the reader seeking a more detailed exploration of this vital area of practice.

## Background

The impact of any infectious disease is a function of its transmissibility and case fatality rate. This single-stranded RNA virus has been fully sequenced and is genetically similar to both SARS-CoV-1 and the Middle East Respiratory Syndrome (MERS) coronaviruses. The latter two pathogens have fatality rates of approximately 10% and 40% respectively. By comparison, the highly contagious 2009 Influenza H1N1 organism had a case fatality rate of only 0.026% (Christian 2020; Majumder 2020). SARS-CoV-2 combines high infectivity (perhaps up to 80% of the European population will be infected in the next 12 months ([bbc.co.uk/news/uk-51730686](https://www.bbc.com/news/uk-51730686))

with a case fatality rate of approximately 2%. Consequently, substantial numbers of critically ill victims need advanced respiratory support and the World Health Organization has declared a global health emergency (WHO 2020).

## SARS-CoV-2 Modes of Spread

SARS-CoV-2 is contained in coughed droplets which immediately settle from the air less than two metres from the patient and on the surfaces of objects touched by infectious individuals; it may also be airborne, suspended in aerosols which are very small particles (down to 300 microns). The latter remain in the atmosphere for some time. Virus particle-containing aerosols are created during coughing, sneezing, expectoration and various upper airway interventions referred to as aerosol generating procedures (AGPs). These include bag-mask or supra-glottic airway (SGA) ventilation (without an adequate seal), High Flow Nasal Oxygenation (HFNO), Non Invasive Ventilation (NIV), and extubation. Laryngoscopy, tracheal intubation, tracheostomy, cricothyroidotomy, bronchoscopy and CPR (without a protected airway) may all create aerosols in the presence of high gas flows. About half of all SARS-CoV-1 victims in the 2003 Canadian SARS outbreak were health care workers (HCWs) (PHE 2020) and as many

as 9% of those who performed intubation of these patients contracted the disease; several died (Caputo 2006).

### Personal Protective Equipment

These considerations inform what Personal Protective Equipment (PPE) should be worn during intubation of patients with this high consequence infectious disease. Appropriate AGP PPE includes a full-length waterproof long-sleeved gown, double gloves, hat, washable shoes, eye protection (wrap-around defog goggles or visor) and a correctly fit-tested high-grade filtered face piece (FFP3) N95 respirator (Cook 2020; Brewster 2020). All staff should undergo systematic training in donning and, crucially, doffing (removing) this PPE. Self-contamination is common during doffing. HCWs should always have a PPE buddy to ensure compliance with best practice. Thorough handwashing with a lipid solvent like soap is mandatory (PHE 2020).

### Intubation - Overall Philosophy

The highest concentrations of SARS-CoV-2 particles are found in the sputum and upper airway. Intubation thereby exposes the operator to high viral loads which are associated with more severe disease. To diminish this risk it is important that airway management is rapid and smooth, without being hurried. Operators should aim to achieve their best effort in as minimal a number of attempts as possible. Simulated training in full PPE using a well-designed COVID-compliant guideline & algorithm (Figures 1 & 2) together with a cognitive aid such as the Vortex approach (Figure 3) and specific COVID-19 intubation checklist (Figure 4) is required to achieve prompt and complication-free intubation under pressure.

### When, Where and Who

Plotting the trajectory of physiological decline is demanding and experienced intensivists are required at the bedside.

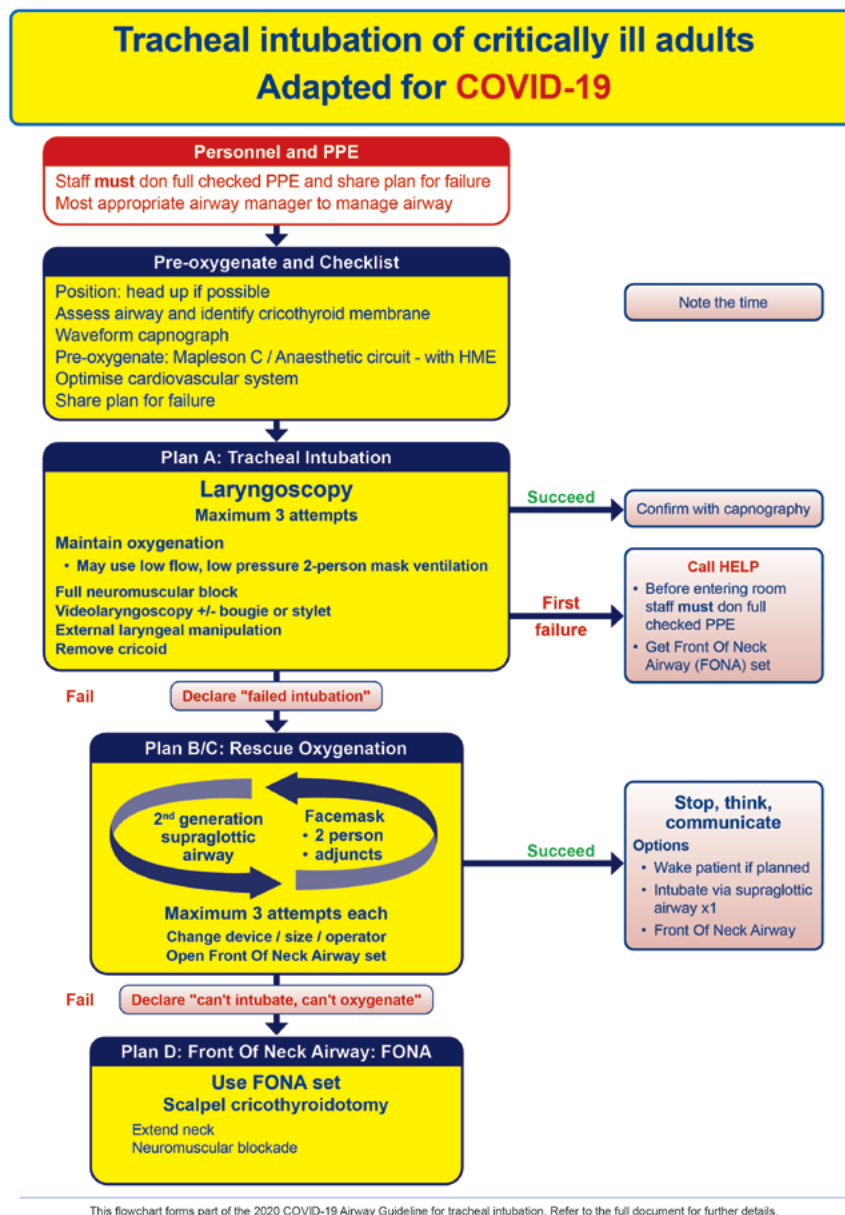
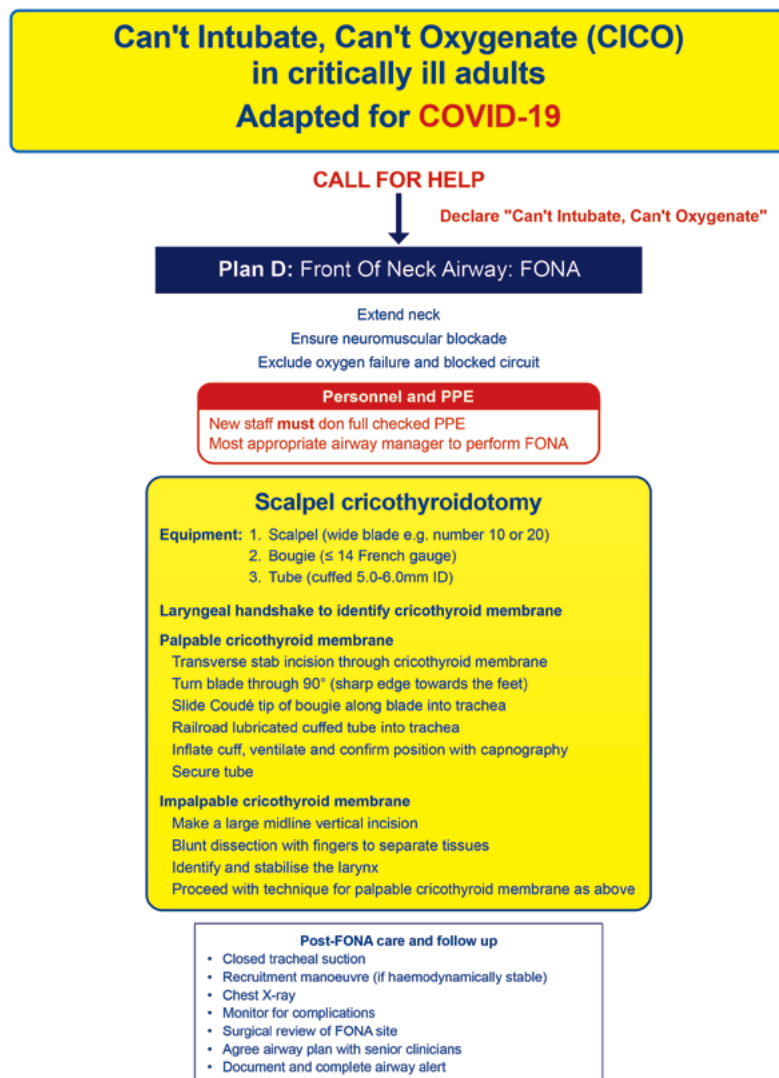


Figure 1. COVID-19 airway management consensus guideline. Cook et al. 2020, with permission.

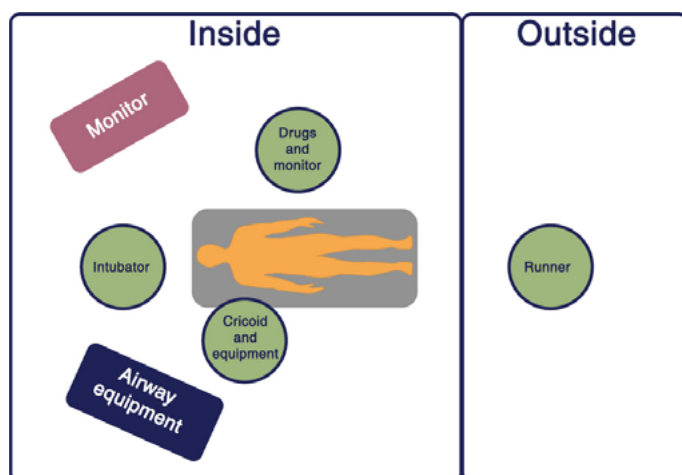
Whenever possible, intubation should be done before patients are in extremis. Persisting with NIV, CPAP or HFNO when a patient is not responding to these modalities is associated with poorer outcomes. Delayed decision-making may precipitate crises which entice staff to accept inadequate preparation and planning in situations fraught with logistical challenges - which in turn make it difficult to rectify oversights easily or quickly.

To minimise the risk of nosocomial infection of HCWs, intubation should ideally be performed in a cleaned negative pressure isolation room with at least 12 air changes/hour. Failing this, a neutral pressure room with the doors closed (Wax 2020). If it has been used before for AGPs, it should have been cleaned after no less than 20 minutes (PHE 2020). Wherever it occurs, efforts must be made to reduce the number of staff exposed to aerosols,





**Figure 2.** COVID-19 eFONA consensus guideline. Cook et al. 2020, with permission.



**Figure 5.** COVID-19 airway team. Cook et al. 2020, with permission.

droplets and fomites by deploying the lowest number of personnel consistent with safe airway management. The airway team can be reduced to an operator, an assistant and one other - who administers drugs, checks monitors and coordinates. A fourth member acts as an immediately available runner outside the room (**Figure 5**). As these patients admit no margin for error, the operator must be experienced in critical care intubation, be reasonably expected to achieve first pass success and able to work without immediate back-up. If it is believed a second operator could be needed, that person should be immediately on hand just outside the room wearing full AGP PPE.

### Preparation & Checklist

A well-designed airway strategy such as that described in 2018 (Higgs 2018) is crucial. This has been modified for COVID-19 patients (Cook 2020). An intubation checklist modified for this patient population optimises the team's performance (**Figure 4**). The specific airway strategy should be agreed before entering the room and the algorithm and a cognitive aid such as the Vortex (**Figure 3**) (Chrimes 2016) should be visible in the room to act as aide-memoires if difficulty arises. The team should familiarise themselves with each other (identification is difficult when wearing PPE) and write their names on their gowns for easy communication. Every team member should be empowered to raise concerns before, during and after the procedure – a major safety feature of modern airway management performance (Shorrock 2017).

### Intubation Sequence and Maintaining a Safe Apnoea Time

We recommend a modified RSI, aiming to minimise aerosol generation and exposure of the operator to viral particles.

### Preoxygenation

Thorough preoxygenation is vital. We

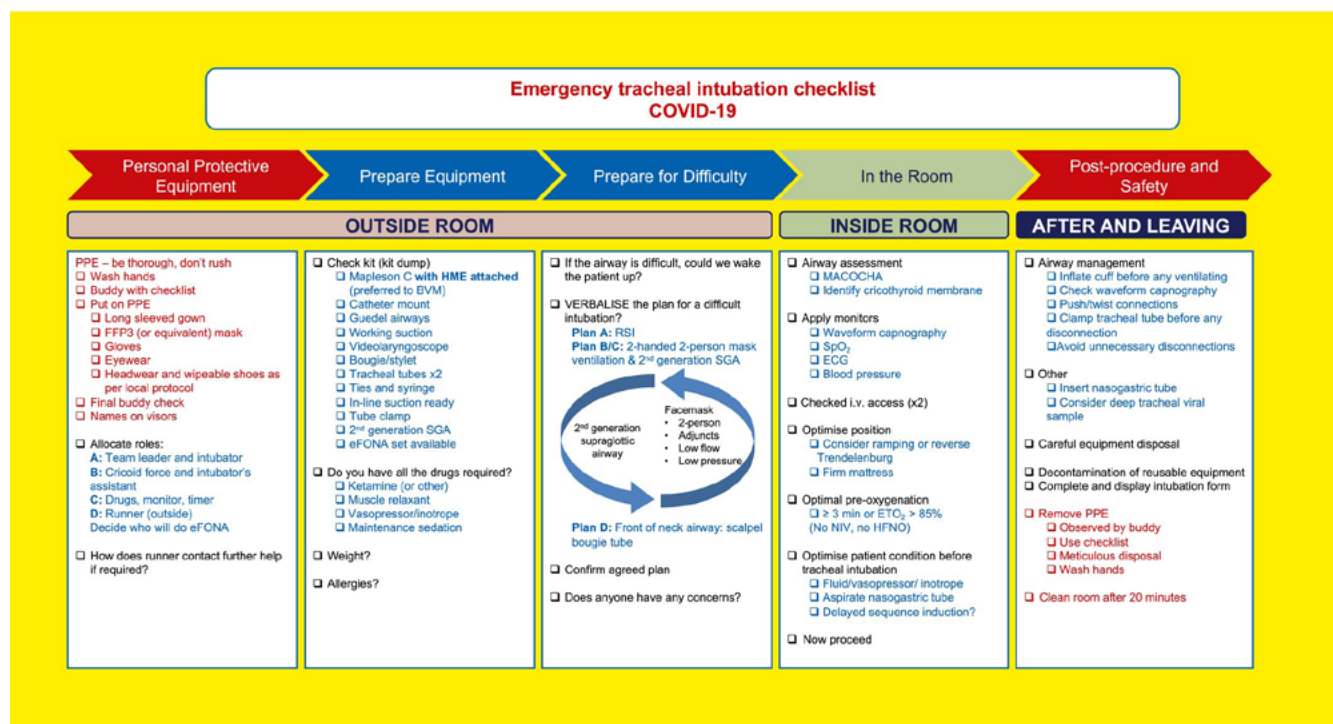


Figure 4: COVID-19 Intubation checklist. From Cook et al. 2020, with permission.

support the recommendation to use closed circle-type circuits or re-breathing Waters circuits (Mapleson C) as these do not expel unfiltered gas into the room. A heat moisture exchanger (HME) with high efficiency viral filter is positioned between the catheter mount and circuit. PEEP can be applied via a tight-fitting anaesthetic face mask and gentle, manually assisted ventilation timed with the patient's inspiratory effort provides an element of pressure support. This helps reassure the operator that the face mask is an appropriate size for the patient. If not, this is the time to swap to a better-fitting mask interface. End-tidal oxygen > 85% is the target but these monitors are rare in the ICU and in their absence, perform preoxygenation for 3–5 minutes.

If the patient is already on a CPAP circuit, this may be used for preoxygenation but the early opportunity to check the fit of the face mask you may later rely on to maintain oxygen saturation is lost. Using this technique also means that formal MACOCHA-based airway assessment

(e.g., mouth opening etc.) is not done (De Jong 2013). In the absence of studies

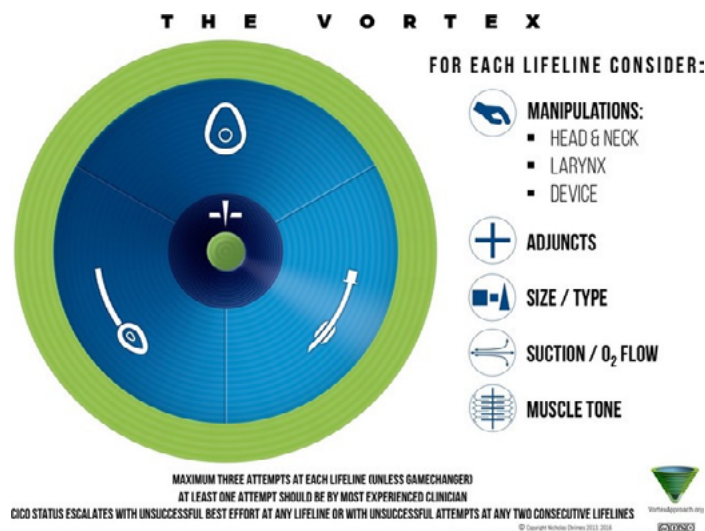
**the highest concentrations of SARS-CoV-2 particles are found in the sputum and upper airway. Intubation thereby exposes the operator to high viral loads which are associated with more severe disease**

excluding transmission of viral particles by HFNO (an AGP which provides only low-level PEEP), it is not recommended for preoxygenation. Of note, HFNO also consumes inordinate quantities of oxygen and en masse may jeopardise a hospital's oxygen supply.

### Induction & intubation

COVID-19 patients are often dehydrated and septic; ketamine 1–2mg/kg IV is an appropriate induction agent. Coughing must be avoided at all costs and rapid-onset neuromuscular blockade is essential. Rocuronium 1.2–1.5 mg/kg is ideal and is likely superior to suxamethonium, as the latter can wear off equally rapidly and make difficult, prolonged airway management even more demanding. Cricoid pressure is used if appropriate and released promptly if difficulty is encountered. This includes difficulty with facemask ventilation, laryngoscopy, tube insertion, when an SGA is inserted or if active vomiting occurs.

Severe COVID-19 pneumonitis may cause precipitous and life-threatening desaturation. The safe apnoea time can be extended by applying gentle CPAP using an anaesthetic face mask with a good seal. This is best achieved using a two-handed technique. Only use facemask positive pressure ventilation if required to prevent/treat hypoxaemia. A leak risks



**Figure 3.** The Vortex cognitive aid. Chrimes 2016, with permission.

aerosolisation. Use low inflation pressures and low fresh gas flows to reduce this hazard. Sensible use of a Guedel airway, after full paralysis, helps overcome any upper airway obstruction which may be contributing to high inflation pressures. Nasal oxygen at low flow (6L/min) is favoured by many, but the operator must be prepared to use positive pressure ventilation if apnoeic oxygenation fails in these patients with significant V/Q mismatch.

Ventilation using a second generation SGA is an alternative but involves instrumenting the upper airway directly (AGP) and if high pulmonary inflation pressures are necessary to recruit alveolar lung units, a leak at the larynx may occur which is more difficult to control than when using a meticulous face mask technique. The operator should make this choice based on their own skill-set and the post-induction behaviour of the patient's upper and lower airways. Prior experience of airway management in critically ill patients is a substantial advantage in this regard.

The same is true of minimising the number of laryngoscopy attempts as repeated instrumentation risks desaturation and increases HCW exposure. Videolaryngoscopy (VL) in experienced hands offers the best chance of first pass

success because the view is better but also because direct laryngoscopy necessitates the operator coming very close

**■ a well-designed airway strategy such as that described in 2018 is crucial.**

**This has been modified for COVID19 patients. An intubation checklist modified for this patient population optimises the team's performance ■**

to the patient's upper airway. VLs with a remote screen allow the operator to keep their arms relatively straight such that their own airway is distant from the patient's mouth and nose. Disposable VLs are preferable as cleaning reusable devices may contaminate HCWs.

Inflate the cuff to 20-30 cmH<sub>2</sub>O BEFORE any ventilation occurs. Confirm endotracheal intubation with waveform capnography. Auscultation is difficult when wearing PPE. Consider ultrasound or early chest radiography. It is important

to record the depth of the tube as partial dislodgement is common and gas leaks are aerosol-generating. It is our practice to insert a naso-gastric tube immediately after securing the tube to minimise upper airway interventions and to take a (closed) tracheal suction specimen in patients in whom COVID-19 is not yet proven. Dispose of all devices as soon as they are no longer required. It is important that the tracheal tube (a) is long enough to enable it to be clamped (see later) and (b) allows for bronchoscopy if this becomes necessary.

It is wise to ensure a bolus vasopressor is immediately available as sepsis, high intra-thoracic pressures and occasional SARS-CoV-2 induced cardiomyopathy may precipitate haemodynamic collapse at induction.

### Unanticipated difficult intubation

It is important to plan what the airway manager will do should difficulty arise. This should follow a familiar standard approach such as the DAS Critically Ill intubation algorithm, modified for COVID-19 patients (Cook 2020). As discussed above, this may include sealed face mask or second generation SGA ventilation. It is imperative to achieve a best effort with these techniques in the fewest number of attempts to minimise staff contamination. If an emergency front-of-neck airway (eFONA) becomes necessary, we recommend the scalpel-bougie-tube technique. Cannula techniques using high flow oxygen generate significant aerosols and are contraindicated. Efforts to continue oxygenation via the upper airway during an eFONA crisis are likewise contra-indicated as this too will cause aerosol contamination.

### Post-Intubation Airway Management

All airway interventions, including even emergent reintubation, require all staff to be fully donned in AGP PPE. Tube displacement is potentially disastrous when the

trachea contains high concentrations of virus. The initial insertion depth should be recorded and checked at least every shift and whenever respiratory deterioration occurs. The cuff pressure should be monitored regularly: ensure there is no leak. Inflation to at least 5 cmH<sub>2</sub>O above the peak inspiratory pressure is advised. This also applies during recruitment manoeuvres. This may result in mucosal ischaemia, but is acceptable as it is crucial to protect attendant staff. If the cuff is damaged, prompt reintubation taking the same precautions as above is required. Aerosol contamination can be minimised by occluding the throat with a wet pack pro tem until the faulty tube is replaced.

Closed suction apparatus is mandatory. During planned circuit disconnections (e.g., to turn, prone or transfer the patient, blocked HME changes, etc.), or inadvertent disconnections which cannot be rectified immediately, the tube should be clamped and the ventilator paused.

### Anticipated Difficult Intubation in COVID-19 Patients

There are many techniques which are used in this extremely hazardous situation. Most, especially awake methods, generate voluminous aerosolisation. The risk-benefit can only be weighed on an individual basis but COVID-19 status lowers the threshold to resort to asleep techniques like hyperangulated VL or intubation through an SGA (Higgs 2005) with, for instance, an Aintree Intubation Catheter.

### Disclosures

Andy Higgs co-authored the UK and Australian guidelines (Cook 2020; Brewster 2020) and is Treasurer of the Difficult Airway Society. He is Chair of the joint Difficult Airway Society – Intensive Care Society- Faculty of Intensive Care Medicine- Royal College of Anaesthetists committee on intubation of the critically ill adult. ■

### Key Points

- COVID-19 is a newly recognised viral infection caused by a novel Coronavirus, Severe Acute Respiratory Syndrome-CoronaVirus-2.
- Severe type one respiratory failure complicates between 14-17% of confirmed cases.
- Airway operators are particularly vulnerable to contracting COVID-19.
- All staff should undergo systematic training in donning and, crucially, doffing (removing) personal protective equipment (PPE).
- It is important that airway management is rapid and smooth, without being hurried. Operators should aim to achieve their best effort in as minimal a number of attempts as possible.
- Whenever possible, intubation should be done before patients are in extremis.
- To minimise the risk of nosocomial infection of HCWs, intubation should ideally be performed in a cleaned negative pressure isolation room with at least 12 air changes/hour.
- Every team member should be empowered to raise concerns before, during and after the procedure – a major safety feature of modern airway management performance.
- There are many techniques which are used in this extremely hazardous situation. Awake methods generate voluminous aerosolisation. The risk-benefit can only be weighed on an individual basis.

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