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Airway Management in COVID-19 as Aerosol Generating Procedure

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Abstract

2020 has seen the whole world battling a pandemic. Coronavirus Disease 2019 (COVID-19) is primarily transmitted through respiratory droplets when in close contact with an infected person, by direct contact, or by contact with contaminated objects and surfaces. Aerosol generating procedures (AGPs) like intubation have a high chance of generating large concentrations of infectious aerosols. AGPs potentially put healthcare workers at an increased risk of contracting the infection, and therefore special precautions are necessary during intubation. The procedure has to be performed by an expert operator who uses appropriate personal protective equipment (PPE). Modifications of known techniques have helped to reduce the chances of contracting the infection from patients. The use of checklists has become standard safe practice. This chapter looks at the current knowledge we have regarding this illness and how we should modify our practice to make managing the airway both safer for the patient and the healthcare workers involved. It addresses the preparation, staff protection, technical aspects and aftercare of patients who need airway intervention. It recommends simulation training to familiarize staff with modifications to routine airway management.

Keywords: coronavirus, airway management, intubation, covid 19, novel virus, aerosol generating procedures

1. Introduction

The current outbreak of the novel coronavirus (Severe Acute Respiratory Syndrome Coronavirus 2 – SARS CoV-2) (COVID-19) was first reported as a cluster of pneumonia cases on Dec 31st, 2019 from Wuhan, Hubei province, China. The World Health Organization (WHO) declared COVID-19 as a public health emergency of international concern (PHEIC) on Jan 30th, 2020, and on March 11th, 2020 WHO characterized the spread of coronavirus as a pandemic.

We know that COVID-19 is primarily spread through respiratory droplets when in close contact with an infected person, or by contact with contaminated objects and surfaces. This puts healthcare workers attending to an infective patient at risk of contracting the illness, and airway management, being an AGP, would be the riskiest of all interventions. AGPs like intubation have a high chance of generating large concentrations of infectious aerosols. Therefore, special precautions are necessary during intubation. The procedure has to be performed by an expert operator

who uses personal protective equipment (PPE) such as FFP3 or N95 masks, protective goggles, disposable long sleeved gowns, disposable double gloves and leg coverings. It is important to recognize mask ventilation and open suctioning of airways as AGPs. If possible, thorough preoxygenation and a rapid sequence induction and intubation (RSII) should be performed. Heat and moisture exchanger (HME) must be positioned between the mask and the breathing circuit or between the mask and the ventilation balloon. Personnel involved in the room should be kept to a minimum and this should be decided beforehand. Small changes to what we know as conventional airway management has been studied and improved upon to keep both COVID 19 patients and staff looking after them safe. This chapter looks at the details inside operating theater and kindly note that the airway management of COVID 19 patient in Intensive care settings are discussed in much details in other chapter in this book.

2. Epidemiology

Corona virus pandemic has evolved since December 2019 in Wuhan, China. Starting from Wuhan the novel virus named Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) invaded all the over the globe [1], causing corona virus disease 2019 (COVID 19) [2]. As of July 2020, infected cases are increasing incredibly around the world. Based on current real-time reports, the estimated infected cases is fifteen million cases reported and more than 610.000 deaths worldwide [3]. The number of infected cases is expected to increase as the second peak is rising in most countries.

3. Transmission

COVID19 pandemic started as an outbreak in Wuhan with mainly transmission from animal to human. This theory was raised after most primarily infected people had visited or worked in seafood the market at Wuhan [4], and later on person to person transmission has been identified [5].

It is well known today that corona virus transmission is established by droplet. This is simply droplets with size 5–10 micron that can carry the virus. However till there is now no clear evidence to support airborne transmission (droplets size less than 5 micron which can carry the virus and able to remain in air for a period of time) but considering that this is still possible, the recommendation is to manage aerosols generating procedures as highly contaminating [6]. Experimental studies have revealed that the virus can be detected on different surfaces after these surfaces are exposed to the virus between 4 hours to 3 days depending on the surface type, the virus is more stable on plastic and stainless-steel surfaces [7].

4. Airway assessment

Airway assessment is recommended whenever there is airway management. Generally speaking the evidence behind airway assessment does not show high specificity nor sensitivity except for previous difficult intubation history, COVID 19 patients mostly need urgent or emergent interventions i.e. intubation. In these circumstances' airway evaluation is not always practical It is worth mentioning that most of these patients are critically ill. COVID 19 is known to cause laryngitis and upper airway oedema is not uncommon in this population which could make

intubation challenging [8]. In COVID 19 patient's general recommendation for airway assessment will apply when it is possible and unanticipated difficult airway should be kept in mind.

COVID 19 patients are critically ill which preclude standard airway assessment.

The difficult airway is defined as:

The difficult airway is “*the clinical situation in which a conventionally trained anaesthesiologist experiences difficulty with facemask ventilation, difficulty in supraglottic device ventilation, difficulty in tracheal intubation or all three*” [9].

4.1 Steps for airway assessment

History: previous difficult intubation history, last meal, previous critical events, smoking, drooling, dysphagia, recent burn in face or upper respiratory system, head or neck trauma, OSA, snoring hoarse voice stridor.

Physical examination: mouth, face, neck, teeth, Mallampati score.

Investigations: X-Ray, USG (ultrasonography), CT, MRI, nasal endoscopy, 3D & Virtual Endoscopy (VE), can be used for airway assessment.

Many score systems and tools have been developed to predict difficult airway; useful tools might be used like:

The 6 D methods (Table 1): [10], **LEMON** score system (Table 2) [11] **MMMMASK** mnemonics (Table 3), or **OBESE** mnemonics (Table 4). (please refer to other book's chapters for more details).

The most important recommendation for health care provider who will take a history or will do examination of the airway of suspected or infected COVID 19, is to wear full PPE to protect himself or herself from the infection.

5. Personal protection and optimal environment

Health care workers (HCW) are at a high risk to be infected with SARS-COV-2 (COVID 19) in particular during any aerosol generating procedures. As discussed before the main transmission route appears to be by respiratory droplets and contact transmission. Not surprisingly these droplets have very high virus load [13]. In view of this protecting personnel who are managing airways in COVID 19 patients must be at the most priority. Aerosol generating procedures vary in their ability to infect HCW but intubation tracheostomy, non-invasive ventilation (NIV) and bag mask ventilation (BMV) appear to carry the highest risk [14].

All efforts should be made to protect HCW providing airway management this will include many aspects to keep in mind. We can summarize them as following:

- Full PPE (personal protective equipment)
- Surface decontamination
- Equipment decontamination
- Negative pressure room
- Minimizing health care workers during active procedure
- Waste management

Sign of difficulty	Description	Quantitative or qualitative findings reported to be associated with difficulty	Acceptable findings not usually associated with difficulty
1. Disproportion	• Increased size of tongue in relation to pharyngeal size	• Mallampati class III or IV	• Mallampati class I or II
	• Airway swelling	• Possibly difficult to assess	
	• Airway trauma (blunt or penetrating)	• Blunt or penetrating airway trauma	• Midline trachea
	• Tissue consolidation (e.g., secondary to radiation)	• Tracheal deviation	• No contractures of the neck
		• Neck asymmetry	• No surgical airway scar
2. Distortion	• Neck mass	• Voice changes	• Mobile laryngeal anatomy
	• Neck hematoma	• Subcutaneous emphysema	• Easily palpated thyroid cartilage
	• Neck abscess	• Laryngeal immobility	• Easily palpated cricoid cartilage
	• Arthritic changes in the neck joints	• Nonpalpable thyroid cartilage	
	Previous surgical airway	• Nonpalpable cricoid cartilage	
3. Decreased thyromental distance	• Anterior larynx and decreased mandibular space	• Thyromental distance >7 cm (3 finger breadths) measured from the superior aspect of the thyroid cartilage to the tip of the chin	• Thyromental distance ≥7 cm (–3 finger breadths)
		• Receding chin	• No receding chin
4. Decreased Inter-incisor gap	• Reduced mouth opening	• Distance between upper and lower incisors (i.e., inter-incisor gap) <4 cm (<2 finger breadths) • Mandibular condyle fracture • Rigid cervical spine collar	• Inter-incisor gap <4 cm (–2 finger breadths)
5. Decreased range of motion in any or all of the joints of the airway (i.e., atlanto-occipital joint, temporomandibular joints, cervical spine); atlantooccipital range of motion is critical for assuming the sniffing position	• Limited head extension secondary to arthritis, diabetes, or other diseases	• Head extension <35°	• Head extension ≥35° of atlanto-occipital extension
	• Previous neck radiation and/or radical surgery	• Neck flexion <35°	• Cervical spine flexion ≥35°

Sign of difficulty	Description	Quantitative or qualitative findings reported to be associated with difficulty	Acceptable findings not usually associated with difficulty
	Neck contractures secondary to burns or trauma	• Short, thick neck	• Long, thin neck
		Cervical spine collar or cervical spine immobilization	• No cervical spine collar or cervical spine
6. Dental overbite	• Large angled teeth disrupting the alignment of the airway axes and possibly decreasing the inter-incisor gap	• Dental overbite	• No dental overbite

Table 1.
 Shows 6 D methods for airway assessment: [11].

LEMON	Criterion	Score
L	Look externally: • facial trauma • large incisors • beard or mustache • large tongue	(1–4) 1 1 1 1
E	Evaluate: • incisor distance • hyoid-mental distance • thyroid-to-mouth distance	(1–3) 1 1 1
M	Mallampati	1
O	Obstruction	1
N	Neck mobility	1

Table 2.
 Shows LEMON score for airway assessment [12].

MMMMASK	Description
M	Male gender
M	Mask seal which is affected by bread or being edentulous
M	Mallampati grade 3or4
M	Mandibular
A	Age
S	Snoring and OSA
K	Kilograms (weight)

Table 3.
 Shows MMMMASK mnemonics difficult airway.

OBESE	Description
O	Obese (BMI >26 kg/m ²)
B	Bearded
E	Edentulous
S	Snoring
E	Elderly (>55 years)

Table 4.
Shows OBESE mnemonics for difficult mask ventilation.

It is well known today that use of full PPE reduces the risk of infection in corona virus family [15], Based on retrospective study published on March 2020, hospital acquired infection was 41.3% from those 29% were health care workers from different specialties [16].

Level 3 (enhanced) is recommended in COVID 19 suspected or confirmed cases airway management for better understanding it is worth to mention here in summary what are the level of PERSONAL protection for healthcare workers [17] (Table 5).

The person who is performing the intubation should wear a third pair of gloves and remove them immediately after intubation [18].

Minimizing number of people during intubation is preferred in order to reduce risk of exposure. The interval time after intubation should be taken into consideration. The required waiting period will vary between 15 and 30 minutes [19].

Level 1 SICPs	Standard Infection Control Precaution <ul style="list-style-type: none"> • Disposable apron • Disposable gloves
Level 2 CONTACT	DIRECT/INDIRECT CONTACT PRECAUTIONS <ul style="list-style-type: none"> • Fluid-resistant disposable gown • Disposable gloves
Level 2 DROPLET	DROPLET (RESPIRATORY) PRECAUTIONS <ul style="list-style-type: none"> • Fluid-resistant disposable gown • Disposable gloves • Fluid-resistant Type IIR surgical face mask and goggle or visor
Level 2 AIRBORNE	AIRBORNE (RESPIRATORY) PRECAUTIONS <ul style="list-style-type: none"> • Fluid resistant disposable gown • disposable gloves • Filtering face piece 3 (FFP3) respirator and eye protection or a powered hood respirator
Level 3 ENHANCED	ENHANCED PRECAUTIONS <ul style="list-style-type: none"> • Reinforced fluid-resistant long-sleeved surgical gown • Disposable fluid-resistant hood (if wearing a gown without an attached hood) • Full length disposable plastic apron • FFP3 respirator or powered hood respirator • Disposable full-face visor • 2 sets of long or extended cuff non-sterile, non-latex disposable gloves • Surgical wellington boots or closed shoes • Disposable boot covers

Table 5.
Levels of personal protective equipment (PPE) for healthcare workers when providing patient care. (copied from health protection Scotland, "levels of personal protective equipment (PPE) for ward patient care").

Negative pressure rooms with good rates of air exchange (> 12 exchanges per hour) is recommended to minimize risk of airborne exposure, in case not available portable HEPA filters or negative air flow, can be considered to reduce risk.

It is very important to have a clear plan for the airway management team. The plan should be discussed in detail with clarifying the rescue one in case unanticipated difficult airway management appear.

Staff who should avoid involvement in airway management: Immunocompromised or pregnant health care workers are advised not enroll in airway management for COVID 19 patients. Also, HCW above age of 60 years old mortality curve will increase remarkably in COVID 19 and patients with cardiac disease chronic respiratory disease; diabetes; recent cancer; and perhaps hypertension that is why it is recommended to exclude HCW who have any of these co-morbidities [20].

6. Non-invasive methods of ventilation in aerosol generating procedure

6.1 Nasal cannula

Low-flow nasal oxygen (nasal cannula) may provide some oxygenation during apnoea (apnoeic oxygenation) and might therefore delay or reduce the extent of hypoxemia during tracheal intubation [21] however, literature suggests this beneficial effect might be worthless in patients with primary respiratory failure like in COVID 19 patients [22] Till now, there is no evidence that low flow nasal cannula can generate aerosols, in COVID 19 patients so, it is not recommended to use it routinely during intubation [23].

6.1.1 High flow nasal cannula

Using high flow nasal cannula (HFNC) 30–70 L/min significantly increases the risk of spreading exhaled gas [24], debate around using HFNC in COVID 19 considering it prolong apnoea time remarkably however there is few predisposed disadvantage: when used in deteriorating patients it is delaying intubation in severely ill patients who really need intubation, exhausting hospital oxygen reserves as a results in very high demand [25], when used during intubation risk of generating aerosol that carrying the virus [26].

Important note: after a few hours of ventilation by high flow nasal cannula (HFNC), the oropharyngeal airway and trachea become extremely dry, due to a high oxygen flow reaching 60 L/min. Which leads to difficulty in passing the endotracheal tube (ETT). So, make sure that the tube and the intubation equipment are very well lubricated to allow the tube to go easily through the vocal cords. Our personal experience is to soak the pharyngeal cavity with 10 ml 0.9% saline and some gel to allow a sufficient lubrication for this purpose.

6.1.2 Non-invasive ventilation

Data regarding use of non-invasive ventilation (NIV) in COVID 19 patients is limited but based on recent systematic review published recently the evidence for using NIV in COVID 19 patient is currently low in quality however it might reduce mortality and increase risk of healthcare worker transmission [27]. Many centres recommend to use NIV in view of limited resources in pandemic regions or using hyperbaric oxygen therapy in preventing mechanical ventilation in COVID-19 in other centers [28–30].

7. Intubation

7.1 Introduction

Endotracheal intubation is considered a very high-risk procedure in COVID 19 patients. For many reasons usually COVID 19 patients who need intubation urgently are critically ill patients with severe hypoxemia and respiratory failure. Desaturation is very quick because of depleted oxygen reserve and high consumption with regards to severe inflammatory status also involvement of other organ failure makes airway management of these cases are challenging. Special attention to the previous mentioned points may provide avoidance of major complications and avoidable deaths ensuring the safety of healthcare workers involved. Severe hypoxemia during ICU intubation has been reported in 25% [31]. In general, physiologically and anatomically airway management in critically ill patients consider challenging.

7.2 Before intubation

All equipment should be prepared with tracheal intubation checklist (see - **Figure 1**) [32] and preferably COVID 19 airway intubation trolley to be prepared figure [33], medications should be prepared in advance, crash trolley should be handy before progress to intubation.

7.2.1 Communication

In operating theater or in ICU setting delegated person, an outside-room “runner” to provide additional outside-room equipment and medications.

The runner can communicate with the inside personnel using special pager or phone kept inside water seal cover.

COVID-19 Emergency Intubation Checklist			
CHECK BEFORE ENTERING ROOM			
Team	Patient	Drugs	Equipment
<ul style="list-style-type: none"> <input type="checkbox"/> Anaesthesia contacted if difficulty anticipated <input type="checkbox"/> Team introduced: <ul style="list-style-type: none"> • Airway Operator • Airway Assistant • Team Leader/Drugs • In-room Runner: optional • Door Runner • Outside room Runner <input type="checkbox"/> Problems anticipated? 	<ul style="list-style-type: none"> <input type="checkbox"/> ECG, BP, Sats <input type="checkbox"/> Pre-oxygenation <ul style="list-style-type: none"> • FIO₂ 100% • Sitting position 45° <input type="checkbox"/> IV access x 2 <ul style="list-style-type: none"> • 1L fluid on pump set <input type="checkbox"/> Haemodynamics optimised <ul style="list-style-type: none"> • Fluid bolus • Pressor 	<ul style="list-style-type: none"> <input type="checkbox"/> RSI drugs drawn up, doses chosen <input type="checkbox"/> Rescue drugs <ul style="list-style-type: none"> • Metaraminol <input type="checkbox"/> Post intubation sedation plan <input type="checkbox"/> Drug C/I or allergies? 	<ul style="list-style-type: none"> <input type="checkbox"/> 2 Laryngoscopes (tested) <input type="checkbox"/> Tube chosen; cuff tested <input type="checkbox"/> Bougie/stylet <input type="checkbox"/> 10ml syringe <input type="checkbox"/> Tube tie <input type="checkbox"/> Lubricant <input type="checkbox"/> Supraglottic airway sized to pt <input type="checkbox"/> Scalpel + bougie CICO kit <input type="checkbox"/> Airway trolley/bronchoscope outside room <input type="checkbox"/> ETCO₂ <input type="checkbox"/> Viral filter
FINAL CHECK IN ROOM			
<ul style="list-style-type: none"> <input type="checkbox"/> Patient position optimal <input type="checkbox"/> Fluid runs easily <input type="checkbox"/> Suction working <input type="checkbox"/> Facemask with viral filter connected <input type="checkbox"/> ETCO₂ trace <input type="checkbox"/> O₂ running at 15L.min⁻¹ <input type="checkbox"/> Oropharyngeal/nasal airways 		<ul style="list-style-type: none"> <input type="checkbox"/> Airway plans: <ul style="list-style-type: none"> • Plan A: Videolaryngoscopy with bougie/stylet • Plan B: Supraglottic airway • Plan C: Vice grip, 2-person +/- Guedel/NPA • Plan D: Scalpel/bougie/tube 	

Figure 1. Checking list an example of emergency intubation checklist from safe airway society [34].

Optimizing communication: wearing full PPE make communication is really difficult so it is very important to use clear language with loud voice repeating the order to make sure communication is efficient. As recognizing a person with full PPE is somewhat difficult so, it is recommended to put sticker with individual name on top of visor [35].

7.2.2 Virus filters

Using of heat moisture exchanger (HME filter) has been advised by many centers which can filter the viruses including Corona virus by 99 percent. HME filter should be attached most proximal to patient i.e. directly to ETT or between the mask and bag of Ambu, another alternative to HME filter that can be used is high efficiency particulate air filter (HEPA filter). Another HME filter is kept between expiratory limb of anesthesia circuit and anesthesia machine (**Figure 2**).

7.2.3 Video laryngoscope

In covid 19 pandemic Video laryngoscopy is recommended as first line option for airway management the rational be [44]:

Higher chance for ETT pass first attempt, reducing chance of infection for the intubator by increasing the distance between the patient airway and the incubators face also use of special drapes is possible and might increase the level of protection, better intubation view can be achieved especially in full PPE situation where the face shield and goggles (with fog) are obstructing clear view.

Two pieces of video laryngoscope (display, single use probe) are better to be used to make sure the intubator's face is far away from the patient's mouth during the procedure [36] in addition, first pass success rate is much higher in experienced manager with video laryngoscope than direct laryngoscope.

7.2.4 Pre-oxygenation

Preoxygenation is crucial part before intubating covid 19 patients as these patients are ill and prone to very rapid desaturation due to the nature of the disease. When it is possible 3–5 minutes of preoxygenation is recommended using non rebreathing mask with 10–15 liter/O₂ which provide 100% Fio₂, if NRM is not enough modified non invasive ventilation might needed with close circuit and HEPA filter. If bagging the patient is inventible for preoxygenation this should be done with two hand technique with HEPA filter however avoiding bagging the patient is always recommended when it is possible [38].

Ideally pre-oxygenation could avoid necessity of bag mask ventilation but there is no guarantee especially in critical COVID 19 patients.

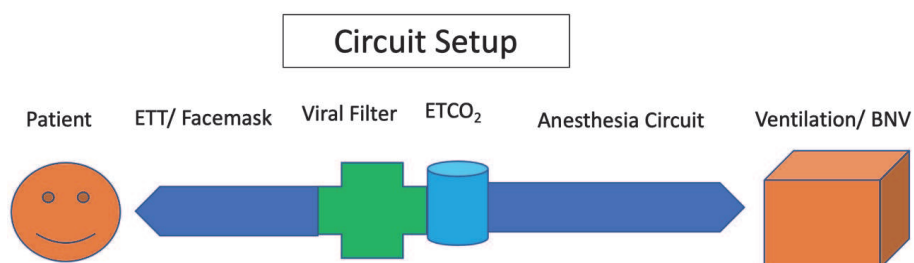


Figure 2.
Ventilation circuits setup (image courtesy Dr. Nabil Shallik).

Keeping the patient in 45 degree (reverse Trendelenburg positioning) may help in increasing apnea time improving the preoxygenation .

7.2.5 Fibroscopic intubation

Flexible bronchoscope can be used in anticipated difficult airway however, it is not advised to be used routinely. But if you in real need in difficult case, better to shift to single use fibro scope [37].

7.3 During intubation

Endotracheal Tube (ETT) confirmation site should be confirmed by ETCO₂ because full PPE will make auscultation much difficult and using stethoscope impractical. Clinically observing chest rising may help in precluding unilateral intubation. Also seeing the ETT passing through vocal cord and recording using video laryngoscopic screen is the best way of confirmation of endotracheal intubation.

As most of COVID 19 patients who need mechanical ventilation will have ARDS so, lung protective mechanical ventilation strategies should be used (target tidal volume less than 6 mL·kg – 1 predicted body weight, plateau pressure ≤ 30 cm H₂O, target SaO₂ 88–95% and pH ≥ 7.25 [38].

The most experience intubator should perform the intubation in order to achieve high first pass success [39] and reduce the contamination and the intubator should use a technique which he is familiar and comfortable with.

Many of novel devices have been introduced trying to achieve high level of protection during the intubation procedure itself, like novel intubation plastic box and plastic cover. Yet there is no definite evidence that such these devices could really protect the intubator from the aerosols [40], few articles suggested that and current studies are ongoing to prove it.

One of the common novel devices recently introduced is intubation novel box. First time had been described by Dr. Lai Hsien-yung [41], The device composed of a transparent plastic cube covering a patient's head and shoulders, with access holes for the intubating procedure and additional hole for an assistance. These device have been discussed in medical literature [42] but more commonly on social media and medical education websites, often being praised for their ingenuity (**Figure 3**).

Brown et al., has created “Barrier System for Airway Management of COVID-19 Patients” it is simply a plastic drape attached to a plastic bag as a protective measure during end tracheal intubation and extubation [43].

7.4 Some tips and tricks during intubation

- Modified Rapid Sequence Induction and Intubation (RSII) is advised as it reduces the time to intubation as securing the airway, with or without cricoid pressure. Drugs of choice are discussed later [44]
- Bag mask ventilation should be minimized unless there it is indicated 3–5 minutes of pre-oxygenation with 100% will help.
- Optimizing the patient position for intubation is recommended as any other intubation tool as video-laryngoscope will be used straight line head which suppose make the intubation more convenient, in obese patient ramping position is recommended.

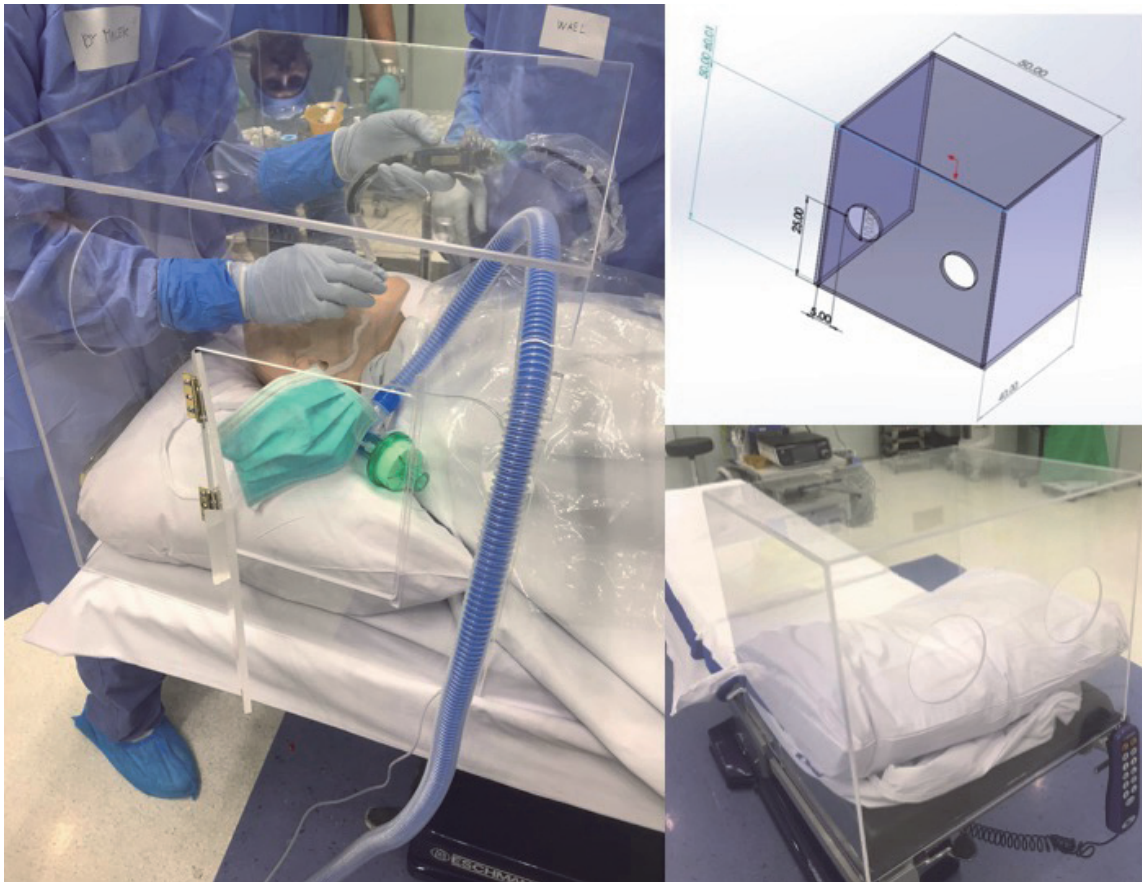


Figure 3.
Plastic intubation box (image courtesy Dr. Nabil Shallik).

- In cardiovascular instability induction agents should be chosen carefully for the best hemodynamic stability i.e. (Ketamine, Etomidate).
- Regardless of the choice of induction agents, ensure that the patient is deep enough before starting intubation to prevent coughing and straining during intubation and this will lead to aerosolization of organisms.
- As RSII is recommended, the rapid acting muscle relaxant should be used in a good dose to ensure complete relaxation that the patient will not cough for example (Succinylcholine 1.5 mg/kg, Rocuronium 1.2 mg/kg).
- As many patients could have severe hypotension, loaded vasopressors should be immediately available for bolus or infusion. Phenylephrine, Ephedrine can be used as a first line.
- Some experts recommended Continuous Positive Airway Pressure (CPAP) with good sealing as this might help to delay desaturation with apneic oxygenation, using proper size oral airway after induction will help in maintaining the airway patency. If CPAP is not enough to prevent desaturation, then bag-mask ventilation should start with two hand technique and minimal oxygen flow and minimal airway pressure. (**Figure 4**)
- While video-laryngoscope is the best option to start yet using adjunctive is pretty helpful for C-MAC Macintosh blade and C-MAC D-blade (Karl Storz, Germany); it is a good idea to use Gum Elastic Bougie (GEB) in case needed. Also, stylet can be used to ease intubation with GlideScope (Verathon, Burnby,

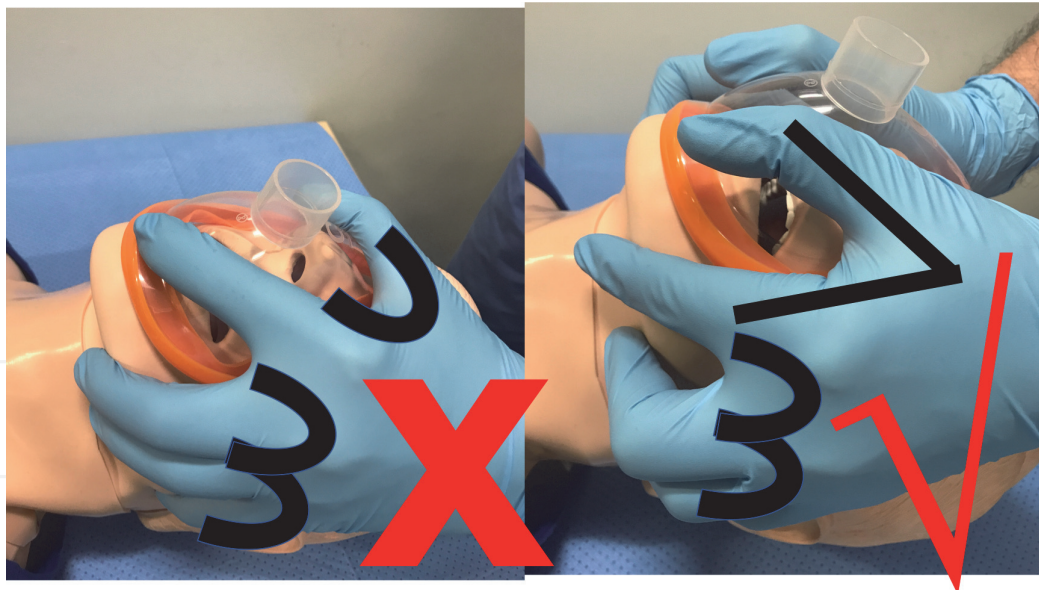


Figure 4.
(✓): Two-handed two-person bag-mask technique with the VE hand position; the second person squeezes the bag. (X): The CE hand position, which should be avoided. (image courtesy Dr. Nabil Shallik).

BC, Canada). If video laryngoscope is not available for any reason direct laryngoscopy could be other option using Macintosh blade with Gum Elastic Bougie (GEB) help.

- Tube size should be reliable with patient condition and should be the biggest diameter size that fit the patient preferably supplied with subglottic suction port.
- After tube insertion under direct vision, inflate the ETT cuff between 20–30 cmH₂O then connect the circuit provided by HME/HEPA filter, anesthesia machine or mechanical ventilator should be in standby mode at this point, after making sure the ETT cuff is inflated well, we can start mechanical ventilation. Waiting for capnography waveform to confirm correct tube site and observing chest movement as mentioned before.
- Please note that auscultation is not practical with full PPE and difficult to perform so, we have to rely on other parameters. Airway pressure can help the intubator or health care provider to figure out a bronchial intubation as well as circuit leak. The reason of not using auscultation is not the impractical procedure, the reason is not to increase the contamination risk)
- During intubation if suction needed it is advised to use close loop suction, in line catheter suction.
- Some procedure will increase the risk of circuit disconnection or ETT displacement so, attention during these procedures must be taken to avoid any complication and contamination: examples of these procedures are patient proning, nasogastric tube insertion, Trans Esophageal Echocardiography (TEE) procedure, or oral suctioning.
- For ultimate reducing possible contamination during ventilation It is recommended by safe airway society to arrange the circuit in this order, i.e. keep the ETCO₂ sample line always distal

- to the patient.

- **Difficult airway management:**

Difficulty can happen in many aspects:

1. Facemask ventilation is not adequate,
2. Placement of a supraglottic airway (SGA) is difficult,
3. Laryngoscopy and tracheal intubation: inability to intubate the patient.
4. Same consideration for non- COVID patients will be applied in COVID19 patients, nevertheless the reason of difficulty, the crucial part is to have a pre-prepared plan and being well ready in order to avoid any serious complications.
5. COVID 19 intubation trolley should be ready.
6. The cause of difficult airway actually is multifactorial including the effect of patient factors, the clinical setting, and the skills of the practitioner.
7. There are many local institutional policies and algorithm to manage anticipated and unanticipated difficult airway. (Figure 5).

Declare the status clearly to team members is very important, in case FONA needed the recommended technique is the one to minimize aerosol generating

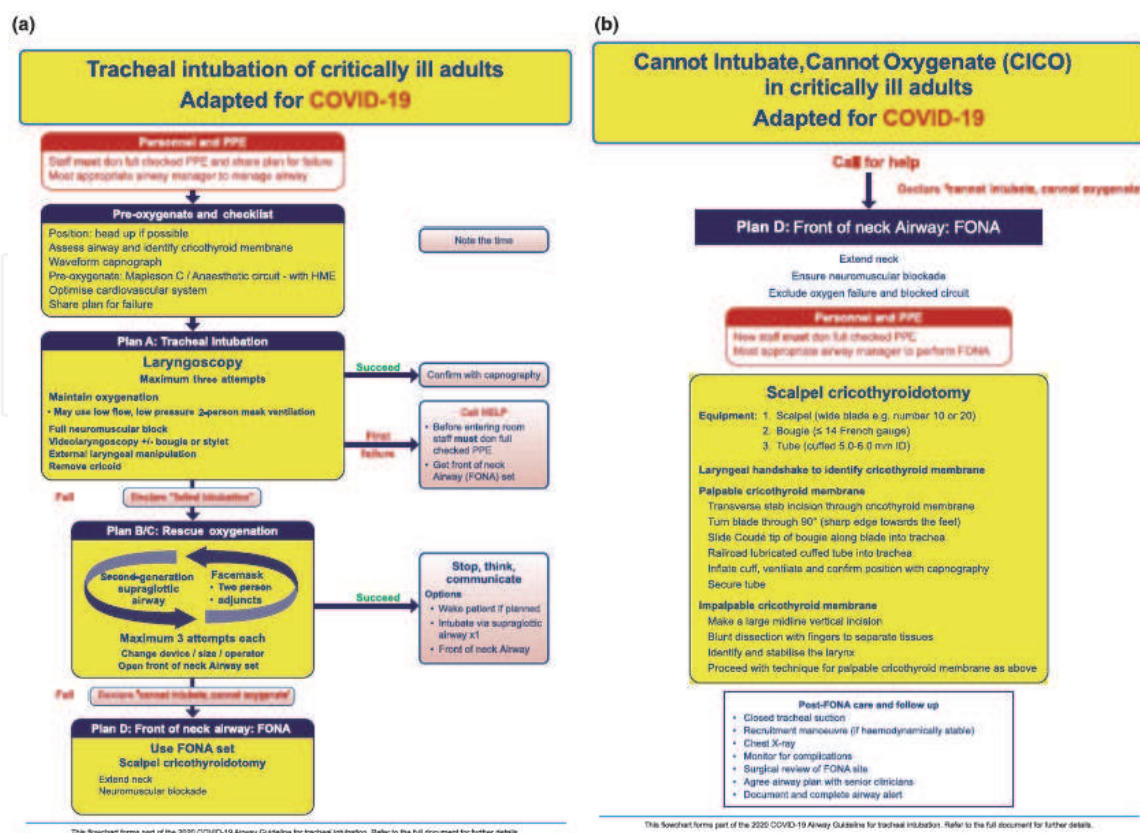


Figure 5.
 (a) Tracheal intubation adapted for COVID 19 patient & (b) CICO adapted for COVID 19 patients. Taken with permission from Difficult Airway Society (DAS) 2015 guidelines [45].

i.e. The scalpel bougie-tube technique as using high flow oxygen could generate aerosols and contamination [46], Front neck kit should be available immediately in case needed however it is better keep nearby the room not inside to avoid contaminate it.

8. Tracheostomy

A lot of COVID 19 patients need long time ventilation that many cases will undergo tracheostomy, currently there is debate about the proper time case selection tracheostomy technique. The major indication for tracheostomy is to facilitate mechanical ventilation for a long period, while reducing complications from a trans-laryngeal endotracheal tube and weaning from ventilation. Airway obstruction, laryngeal oedema might be an emerging feature of COVID-19 which indicate urgent tracheostomy [47, 48].

When elective tracheostomy is done, an inflated tracheostomy tube cuff via which pressure support ventilation can be delivered affords a closed system for controlled weaning of respiratory support.

Tracheostomy in COVID 19 patients is like intubation a high risk for aerosol generating same consideration will apply for intubation however based on recent reports for tracheostomised COVID 19 patients it is recommended to use of enhanced PPE, with PAPRs (powered air-purifying respirators), eye protection, fluid-repellent disposable surgical gown, and gloves If a PAPR is not available, we advise the use of a fit-tested filtering face piece 3 (FFP3) or N95 mask with an additional fluid shield, minimizing number of people during the procedure is necessary.

Surgical tracheostomies were generally favored over percutaneous tracheostomies during the SARS outbreak, however, percutaneous techniques have subsequently advanced and no data are available to establish superiority of one approach over the other from the standpoint of infectious transmission or safety. Single-use bronchoscopes with a sealed ventilator circuit are preferable when doing percutaneous tracheostomies.

Good sedation should ensure during the procedure to avoid cough and muscle relaxant might be used.

9. Extubation

Like intubation, extubation is an aerosol generating procedure (AGPs) and need special attention in COVID 19 patients.

Specific considerations during extubation include [49]:

- i. Strategies for supporting respiration after extubation, such as noninvasive ventilation (NIV) and high-flow nasal oxygen (HFNC), are relatively contraindicated because of their ability to aerosolize SARS-CoV-2
- ii. Extubation should ideally take place in a negative pressure room, if available.
- iii. All non-essential staff should exit the room before extubation.
- iv. Personal protective equipment (PPE) with airborne precautions is required during extubation and for personnel entering the room for a variable period of time after extubation, dependent on room ventilation.

v. Limit the need for subsequent staff interactions with:

- Prophylactic and anti-emetics.
- Adequate analgesia; consider regional anesthesia. (What kind of regional anesthesia for extubation? If it is an advice for surgery it should take place above???)

vi. Perform oropharyngeal suction with vigilance, as this may generate aerosols.

vii. Antitussive drugs, such as Remifentanyl, Lidocaine, and Dexmedetomidine, reduce the risk of coughing and minimize agitation on extubation.

Ensure good sedation before extubation. Efforts to prevent cough during extubation should be implemented including possible use of medications like Dexmedetomidine, Lidocaine, and/or opioids if there is no contraindication.

10. Extubation technique

Many techniques have been described to minimize exposure to aerosols during extubation although no clear evidence behind them [50].

- Extubation under plastic cover
- Mask over tube technique with attached filter
- Extubation with LMA as alternative to ETT (contraindicated; as it can generate aerosol and contact contamination,
- Extubation with lightweight barrier hood device [51]

10.1 Endotracheal tube exchange

On the ICU there are times the ETT may need to be changed, either due to blockage or damage to the cuff. This is usually done with a tube exchanger, with the new ETT railroaded over the bougie. The lungs of a COVID-19 patient are diseased and more prone to trauma. It is advised to avoid blindly introducing a bougie into the trachea with the possibility of advancing it too deep, and thus damaging the airways, with a potential to cause a pneumothorax. If the airway is not predicted to be difficult, paralyzing the patient, preoxygenation, extubation and then reintubation with a fresh ETT using a video-laryngoscope would be the gentler way to do it.

11. Single vs. reusable equipment during COVID19 outbreak

- Ideally single use equipment is the best option in such a huge pandemic like COVID 19 pandemic, however because of the high transmission rate, applying this does not look practical especially with enormous number of infected people. It is really advised to avoid reusable equipment that will guarantee

patient and health care provider safety as well. Actually, this fact utmost true when invasive equipment is used [52, 53].

- As a general rule any non-invasive equipment contaminated with patient secretions (blood, urine, vomit, or faces) or has been used with contact in suspected or confirmed COVID 19 patients must decontaminated with,1,000 parts per million available chlorine (ppm av. cl) [54]
- The real concern in single use equipment is shortage of these devices, and in highly demand situation replacement will be quite difficult.
- If re-usable equipment has been used special consideration should be taken in decontamination process following local and manufacture recommendation is a must.

12. Conclusion

Managing the airway in a patient who is potentially infective with a droplet infection needs thorough understanding of the disease process and the modifications to airway management technique, that have been seen to reduce harm to the patients and reduce spread to the airway operators. The COVID 19 pandemic has taught us better ways to manage the airway, which can be used in all aerosol generating procedures. Formulating a plan early with good preparation and using checklists, meticulous patient assessment, personal protection for staff, modification of technique and good after care are the cornerstones to achieving safe airway management in COVID19 patients and all AGPs in general.

(Best Practice Recommendations) Airway Management in Patient with Suspected Novel Coronavirus (COVID19): Permission from Qatar Difficult Airway Society (QMAD) (Figure 6)

Keep in your mind YOUR personal protection is the priority.

1. Please review the material and use droplet/contact isolation precautions (PPE – face mask, long-sleeved gown, gloves, overhead, overshoes with eye protection and fit-tested particulate respirators (N95 or equivalent, or higher level of protection) when interacting with patients' blood, body fluids, secretions (including respiratory secretions) and non-intact skin.
2. Standard precautions should always be routinely applied in all areas of health care facilities. Standard precautions include: hand hygiene; prevention of needle-stick or sharps injury; safe waste management; cleaning and disinfection of equipment; and cleaning of the environment.
3. Before intubation, review and practice wearing and removing the protective barrier mask, gloves and clothing of the infected patient. Pay close attention to avoid self-contamination.
4. Most skilled anesthetists available to perform suitable airway management technique, if possible. Avoid junior intubation for sick patients.
5. Check carefully the followings; standard ASA monitoring, I.V. access, equipment, drugs, ventilator and suction.



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Airway Management in Patient with Suspected Novel Coronavirus (nCoV) (Best Practice Recommendations)

1. Keep in mind YOUR personal protection is the priority.
2. Please review the material and use droplet/contact isolation precautions (PPE – face mask, long-sleeved gown, double gloves, overhead, overshoes with eye protection and fit-tested particulate respirators (N95 or equivalent, or higher level of protection) when interacting with patients' blood, body fluids, secretions (including respiratory secretions) and non-intact skin.
3. Standard precautions should always be routinely applied in all areas of health care facilities. Standard precautions include hand hygiene; prevention of needle-stick or sharps injury; safe waste management; cleaning and disinfection of equipment; and cleaning of the environment.
4. Before intubation, review and practice wearing and removing the protective barrier mask, gloves and clothing of the infected patient. Pay close attention to avoid self-contamination.
5. Most skilled anesthesiologists available to perform suitable airway management techniques, if possible. Avoid junior intubation for sick patients.
6. Check carefully the followings; standard ASA monitoring, I.V. access, equipment, drugs, ventilator, and closed suction unit.
7. Avoid awake fiberoptic intubation unless highly indicated. An atomized local anesthetic will aerosolize the virus.
8. Consider disposable Videolaryngoscopes to protect your face or single use Fiberscope.
9. Avoid mask ventilation, unless absolutely essential. If unable to intubate, place the SGA as a bridge. Avoid using SGA as a primary airway. Avoid/minimize the leak during Positive Pressure Ventilation.
10. Plan for rapid sequence intubation (RSI) and ensure skilled assistants able to perform cricoid pressure if needed. RSI may need to be modified if the patient has a very high alveolar-arterial gradient and is unable to tolerate a short period of apnea or has a contraindication to succinylcholine. If manual ventilation is predicted, small tidal volumes should be applied.
11. Three to five minutes of preoxygenation with oxygen 100% and RSI in order to avoid manual ventilation of the patient's lungs and potential aerosolization of virus from airways.
12. Avoid THRIVE/HFNC because it will aerosolize the virus and spread the infection inside and outside the patient's airway.
13. Ensure high-efficiency Heat & Moisture Exchange (HME) filters interposed between facemask and breathing circuit or between the facemask and self-inflating (Ambo) bag. These HME filters should be antibacterial and antiviral characters.
14. Ensure using two HME filters, one beside Endotracheal Tube (ETT) before right angle connection and a second filter at the expiratory limb of the anesthesia circuit.
15. ETCO₂ sample line is connected to sideway of the HME filter.
16. After intubation, confirm the correct position of the tracheal tube.
17. Start mechanical ventilation only after cuff inflation and stabilize your patient.
18. Avoid patient coughing during extubation and put a wide plastic cover around the face mask.
19. All airway equipment must be sealed in a double zip-locked plastic bag and removed for decontamination and disinfection.
20. Assigned personnel should then wipe down surfaces with appropriate disinfectant (as directed by our hospital infection control policy) after exiting the negative-pressure atmosphere.
21. After removing your PPE, avoid touching your hair or face before washing hands.
22. The HMC infection control department will provide additional updates regarding the management of patients at the various hospital facilities.

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 6. [Singapore Respiratory Intubation Society \(SIRIS\)](#)

Figure 6.
Qatar difficult airway society (QMAD) airway management in COVID 19 patients.

6. Avoid awake fiberoptic intubation unless highly indicated. Atomized local anesthetic will aerosolize the virus. Consider disposable videolaryngoscopes.
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8. Three to five minutes of preoxygenation with oxygen 100% and RSI in order to avoid manual ventilation of patient's lungs and potential aerosolization of virus from airways.
9. Avoid THRIVE/HFNC because will aerosolize the virus and spread the infection inside and outside patient's airway.
10. Ensure high efficiency hydrophobic filter interposed between facemask and breathing circuit or between facemask and self-inflating (Ambo) bag.
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12. Start mechanical ventilation and stabilize your patient.
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