



Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.

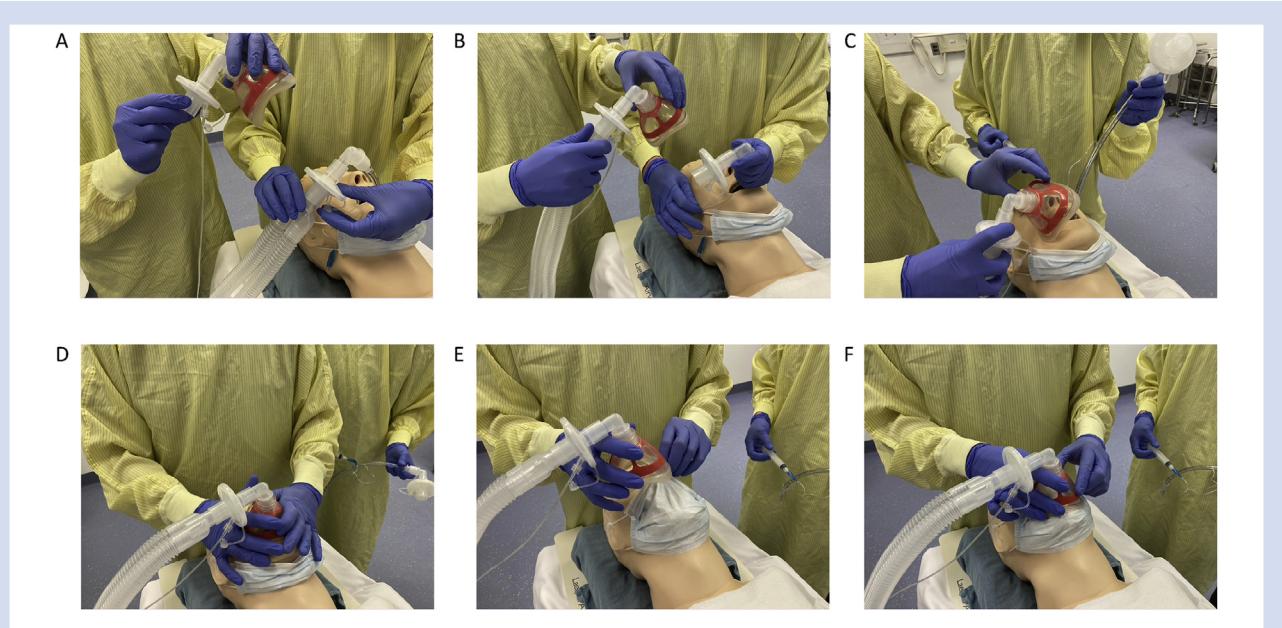


Fig. 1. Extubating COVID 19 Patients is a SNAPP. A – S – Sampling line attached to new filter. B – N – New filter is attached to circuit. C – A – Airway is removed. D – P – Place oxygen mask on patient. E and F – P – Pull surgical mask up and reapply oxygen mask.

can then be applied either with nasal prongs as D'Silva and colleagues describe or with a simple oxygen facemask on top of the surgical mask. We have summarized these steps in [Figure 1](#). We thank D'Silva and colleagues for their article, and hope that our suggestions further improve upon the safety of their extubation technique for COVID-19 patients.

Declaration of interest

The authors declare that they have no conflicts of interest.

Reference

1. D'Silva DF, McCulloch TJ, Lim JS, Smith SS, Carayannis D. Extubation of patients with COVID-19. *Br J Anaesth Advance Access* 2020; 125: e192–5

doi: 10.1016/j.bja.2020.03.016

Advance Access Publication Date: 24 April 2020

© 2020 British Journal of Anaesthesia. Published by Elsevier Ltd. All rights reserved.

Extubation of patients with COVID-19

David F. D'Silva^{1,2,3,4,*}, Timothy J. McCulloch^{1,5}, Jessica S. Lim^{1,2}, Sanchia S. Smith^{1,6} and Daniel Carayannis¹

¹Department of Anaesthetics, Royal Prince Alfred Hospital, Camperdown, Australia, ²Department of Anaesthetics, Concord Repatriation Hospital, Concord, Australia, ³Department of Anaesthetics, Prince of Wales Hospital, Randwick, Australia, ⁴Faculty of Medicine, University of New South Wales, Kensington, Australia, ⁵Faculty of Medicine, University of Sydney, Camperdown, Australia and ⁶Department of Anaesthetics, Canterbury Hospital, Campsie, Australia

*Corresponding author. E-mail: David.dsilva@health.nsw.gov.au

Keywords: aerosol generating procedure; airway management; coronavirus; COVID-19; mechanical ventilation; tracheal extubation

Editor—Recommendations for anaesthetic management of patients with coronavirus disease 2019 (COVID-19) have recently been published.^{1–3} These guidelines emphasise techniques for safe tracheal intubation, and it has been recommended that all COVID-19 patients be intubated using a rapid sequence induction.² However, we are not aware of published recommendations for minimising aerosolisation and droplet expulsion during extubation.

Extubation is an aerosol-generating procedure, commonly associated with coughing, which necessitates proximity of the anaesthetist to the patient.³ Significantly, patients requiring intubation for respiratory failure or emergency surgery are likely to remain infective at the time of extubation.⁴ Leaving COVID-19 patients intubated after emergency surgery

provides the best protection against coughing and aerosolisation. Complications of prolonged ventilation and resource constraints during the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) pandemic make this strategy inappropriate. The following is a summary of our extubation guidelines for COVID-19 patients, including description of an extubation technique aimed at minimising staff exposure to SARS-CoV-2.

Pre-extubation planning

Parameters for assessing suitability for extubation after general anaesthesia are well described.⁵ This assessment is critical, as commonly used rescue strategies are complicated by increased risk of exposure to healthcare workers. Specific considerations include:

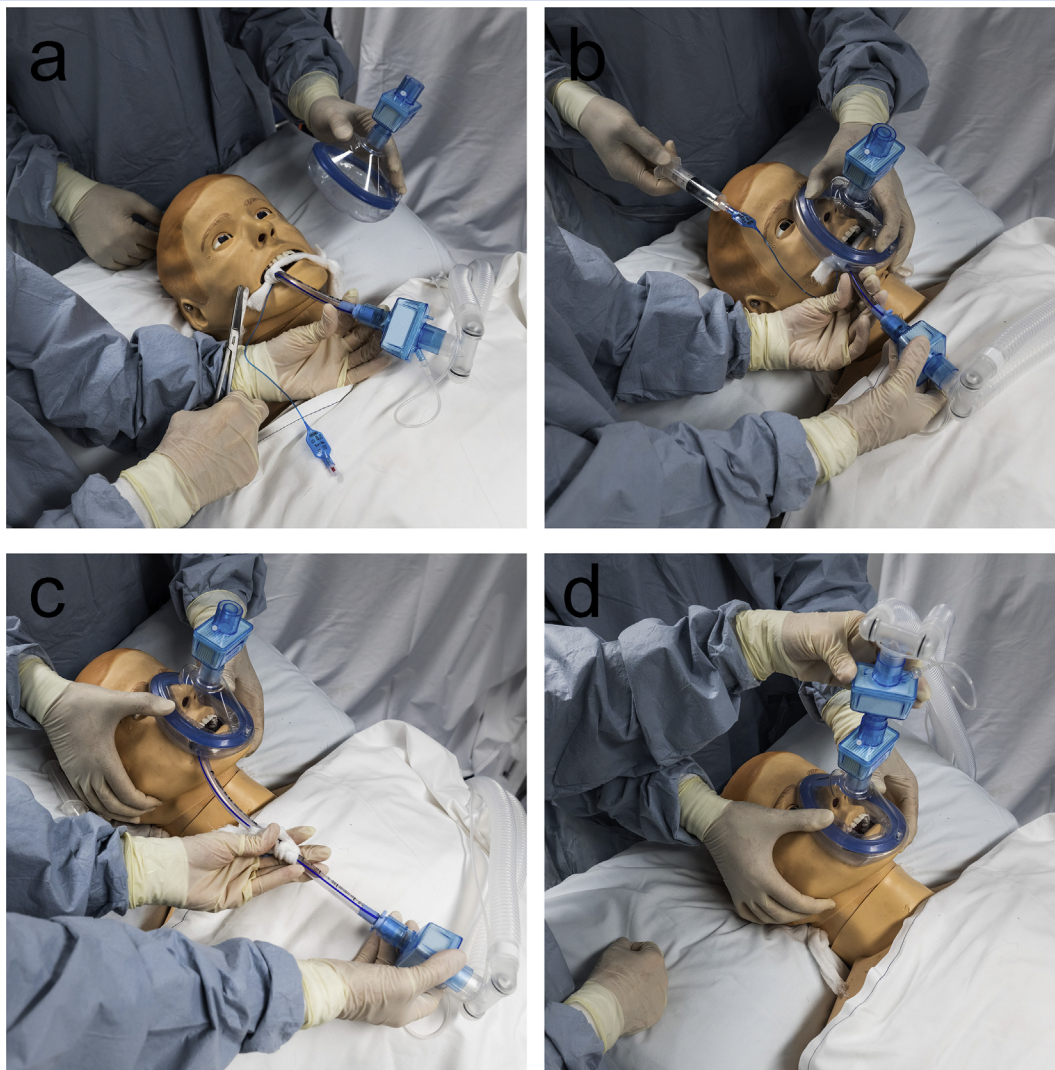


Fig 1. Mask-Over Tube Extubation Technique. (a) Tracheal tube positioned at one corner of the mouth with ties cut. (b) Facemask with airway filter positioned to create a seal over the face and tracheal tube. (c) The assistant withdraws the tracheal tube from under the side of the facemask using a two-handed technique to control the tracheal tube. (d) Tracheal tube has been detached and circuit has been connected to the second airway filter on the facemask.

- (i) Strategies for supporting respiration after extubation, such as noninvasive ventilation and high-flow nasal oxygen, are relatively contraindicated because of their ability to aerosolise SARS-CoV-2.³
- (ii) Extubation should ideally take place in a negative pressure room, if available.
- (iii) All non-essential staff should exit the room before extubation.²
- (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.^{6,7}
- (v) Limit the need for subsequent staff interactions with:
 - (a) Prophylactic anti-emetics.⁸
 - (b) Adequate analgesia; consider regional anaesthesia.
- (vi) Perform oropharyngeal suction with vigilance, as this may generate aerosols.⁹
- (vii) Antitussive drugs, such as remifentanyl, lidocaine, and dexmedetomidine, reduce the risk of coughing and minimise agitation on extubation.^{10,11}

Extubation technique

We have developed a technique to minimise exposure of staff in proximity during extubation. The 'mask over tube' technique described as follows uses a second airway filter. The second airway filter is critical to ensuring that disconnecting the circuit on extubation does not allow the anaesthetist to be exposed directly to droplets or aerosols produced by extubation or associated coughing.

Exchange for a supraglottic airway (laryngeal mask airway) before emergence from anaesthesia could be considered as an alternative technique for reducing the risk of coughing. We do not recommend this technique because of the risk of exposure to infective secretions during additional airway interventions, and manipulation of a supraglottic airway may trigger coughing or laryngospasm.

Mask over tube extubation (Fig. 1)

- (i) Position the patient 30° head up.
- (ii) The anaesthetist and assistant are positioned behind the patient's head, attempting to avoid exposure to any coughing.
- (iii) Optimise anaesthetic face-mask seal. (Before induction of general anaesthesia, the anaesthetist will have ensured correct face-mask size, adjusted inflation of mask cuff, and shaved any facial hair.)
- (iv) Attach a second airway filter to the face mask. The CO₂ sampling port should be capped.
- (v) Position the endotracheal tube (ETT) to one side of the mouth, closest to the anaesthetic assistant's position for extubation.
- (vi) Position the face mask with second airway filter using a two-handed technique to ensure a seal over the mouth and nose with the ETT exiting under the face mask.
- (vii) There should be no positive airway pressure during extubation: ventilator off with no or low fresh gas flow. Consider attempting to extubate at end-expiration.
- (viii) Deflate ETT cuff and extubate whilst maintaining face-mask seal.
- (ix) Discard ETT and connect circuit to the second airway filter face mask to the anaesthetic circuit (in the operating theatre) or the non-rebreather valve of a self-expanding bag (in the ICU).

- (x) Maintain a two-handed mask seal until any immediate post-extubation coughing has subsided and regular breathing via the circuit is confirmed.

Post-extubation

- (i) Place a surgical mask on the patient once the anaesthetic face mask is no longer required. Supplemental oxygen can be delivered under a surgical mask via nasal prongs.
- (ii) Staff members should confirm that PPE integrity has been maintained.⁸
- (iii) Doffing should only occur once the patient has been handed over to another staff member. The room requires airborne precautions for a variable period after an aerosol-generating procedure, dependent on room ventilation.⁷

Complications

- (i) The ability to communicate and make rapid changes to plans is inhibited by PPE.⁴ Therefore, it is critical for the airway team to discuss possible complications and plan specific roles before extubation.
- (ii) If laryngospasm occurs, consider early use of pharmacological agents to treat the spasm and avoid or minimise the need for positive-pressure ventilation.
- (iii) If apnoea occurs after extubation necessitating positive-pressure support, consider bag-mask ventilation with a two-handed technique, attempting to minimise positive pressure with small tidal volumes.

The extubation technique described here requires minimal extra equipment (one airway filter). A potential risk of the technique is kinking of the ETT, where it is directed under the mask, although this problem has not occurred during our mannequin testing. We did consider alternative techniques, including passing the ETT through the port of a standard face mask, or the self-sealing port of a bronchoscopy face mask, but those methods involve clamping the ETT to remove the connector and were not always possible depending on the exact geometry of the mask. We have found that the mask-over-tube extubation technique is simple to adopt and teach, and it can be practiced during extubation of elective patients without COVID-19. Strict adherence to PPE is essential for reducing the risk of viral transmission to healthcare providers; however, techniques to reduce droplets and aerosolisation are also strongly recommended. The technique we describe for extubation could reduce the risk to anaesthesia providers.

Authors' contributions

Writing paper: DFD, TJM

Critical reviewing: all authors

All authors read and approved the final version of the manuscript.

Declarations of interest

The authors declare that they have no conflicts of interest.

References

1. Wax RS, Christian MD. Practical recommendations for critical care and anesthesiology teams caring for novel

- coronavirus (2019-nCoV) patients. *Can J Anaesth* 2020; **12**: 1–9
2. Peng W, Pak-Leung H, Hota S. Outbreak of a new coronavirus: what anaesthetists should know. *Br J Anaesth* 2020. <https://doi.org/10.1016/j.bja.2020.02.008>. Adv Access Published February 27
 3. Brewster DJ, Chrimes NC, Do T, et al. Consensus statement: safe airway society principles of airway management and tracheal intubation specific to the COVID-19 adult patient group. *Med J Aust Adv Access Published March 2020*; **16**. <https://www.mja.com.au/journal/2020/consensus-statement-safe-airway-society-principles-airway-management-and-tracheal>
 4. Zhou F, Yu T, Du R, et al. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. *Lancet* 2020; **395**: 1054–62
 5. Difficult Airway Society Extubation Guidelines Group, Popat M, Mitchell V, Dravid R, et al. Difficult airway society guidelines for the management of tracheal extubation. *Anaesthesia* 2012; **67**: 318–40
 6. World Health Organization. *Infection prevention and control of epidemic- and pandemic-prone acute respiratory infections in health care*. Geneva: Report of WHO Guidelines development group; 2014
 7. Clinical Excellence Commission. *Infection control nCoV-2019*. Available from: http://www.cec.health.nsw.gov.au/__data/assets/pdf_file/0006/567987/Infection-control-nCoV-2019-Hospital-Setting-V2-.pdf. [Accessed 14 March 2020]
 8. Wong J, Goh Q, Tan Z, et al. Preparing for a COVID-19 pandemic: a review of operating room outbreak response measures in a large tertiary hospital in Singapore. *Can J Anaesth Adv Access Published March 2020*; **11**. <https://doi.org/10.1007/s12630-020-01620-9>
 9. Center for Disease Control and Prevention. *Interim infection prevention and control recommendations for patients with suspected or confirmed coronavirus disease 2019 (COVID-19) in healthcare settings*. Available from: <https://www.cdc.gov/coronavirus/2019-ncov/infection-control/control-recommendations.html>. [Accessed 14 March 2020]
 10. Tung A, Fergusson N, Ng N, Hu V, Dormuth C, Griesdale D. Medications to reduce emergence coughing after general anaesthesia with tracheal intubation: a systematic review and network meta-analysis. *Br J Anaesth* 2020. <https://doi.org/10.1016/j.bja.2019.12.041>. Adv Access Published February 22
 11. Yang SS, Wang NN, Postonogova T, et al. Intravenous lidocaine to prevent postoperative airway complications in adults: a systematic review and meta-analysis. *Br J Anaesth* 2020; **124**: 314–23

doi: 10.1016/j.bja.2020.03.016

Advance Access Publication Date: 9 April 2020

© 2020 British Journal of Anaesthesia. Published by Elsevier Ltd. All rights reserved.

Extubation barrier drape to minimise droplet spread

Miguel Patino Montoya and Hovig V. Chitilian*

Boston, MA, USA

*Corresponding author. E-mail: hchitilian@mgh.harvard.edu

Keywords: aerosol generating procedure; airway management; COVID-19; extubation; infection control; tracheal intubation

Editor—Transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is thought to occur via aerosolised droplets.¹ Furthermore, reports suggest that asymptomatic carriers are able to transmit the virus.² Anaesthetists are in a particularly vulnerable position as airway manipulation during tracheal extubation can lead to droplet aerosolisation.³ Current testing capacity in the USA does not allow for the routine screening of asymptomatic patients who present for non-elective surgery. Furthermore, there is

an acute shortage of N95 masks and personal protective equipment (PPE), with the existing inventory being rationed for the care of symptomatic or confirmed patients.⁴ In this setting, it is necessary to consider adjunctive approaches to minimise droplet spread.

To protect against aerosolised droplets during extubation, we have started to employ the following strategy. A 1–2 cm slit is made in the centre of a large (137×229 cm) clear plastic sheet. Before emergence from general anaesthesia, the