



Performing tracheostomy during the Covid-19 pandemic: guidance and recommendations from the Critical Care and Acute Care Surgery Committees of the American Association for the Surgery of Trauma

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BACKGROUND

As the Covid-19 pandemic evolves, acute care surgeons, intensivists and other surgical specialists increasingly may be asked to perform a tracheostomy in patients with known or suspected coronavirus-19 infection. Practitioners must be prepared for this inevitability while taking measures to perform the procedure safely for patients in altered or suboptimal conditions and protecting themselves and other healthcare personnel from undue risk of exposure and infection. This document provides a brief overview for those considering performing tracheostomy in known or suspected Covid-19. The information provided here is not intended to supersede clinical judgment. As the current pandemic evolves, some or all of the data and recommendations may not be applicable to future conditions.

CURRENT SEVERITY OF DISEASE IN THE COVID-19 POPULATION

As of 26 March 2020, the Centers for Disease Control and Prevention (CDC) reported 68 440 total confirmed plus presumptive cases of Covid-19 in the USA, with 994 deaths.¹ These numbers are expected to change daily as more data are collected and more testing for the virus is performed. As of 16 March 2020, the last report of outcome data by the CDC,² 508 patients were known to have been hospitalized in the USA, with 121 (23.8%) admitted to an intensive care unit (ICU). ICU admissions were highest among adults 75–84 years old and lowest among adults 20–44 years old. Among the 44 cases with a known outcome, 80% of deaths have been in patients 65 years of age or older and 20% among adults 20–64 years of age. The largest percentage of severe outcomes are in those 85 years of age or older.

The early experience from Wuhan, China, on 138 hospitalized patients reported that 36 (26.1%) were admitted to ICU for complications, 22 (61.1%) of whom were diagnosed with ARDS and 17 (47.2%) of whom were placed on mechanical ventilation.³ Discharge data were incomplete, with some patients still hospitalized at the time of the report. Six (4.3%) of the admitted patients died. Of the 47 (34.1%) who were discharged, the median hospital stay duration was 10 days.

UTILITY AND BENEFITS OF TRACHEOSTOMY IN THE GENERAL CRITICAL CARE POPULATION

Tracheostomy has many known benefits in the critically ill and injured, but its utility in the recovery of patients with Covid-19 is unknown. In previous studies, early tracheostomy has been associated with reductions in the duration of mechanical ventilation⁴ and short-term mortality and in specialized populations such as those with traumatic brain injury, reduced ICU and hospital days and risk of nosocomial pneumonia.⁵

In the trauma population, percutaneous bedside tracheostomy is common and safe. In patients with respiratory failure due to coronavirus, transport out of the ICU for open tracheostomy (OT) may be limited or restricted due to risk of viral exposure to staff and to physiological instability, making bedside percutaneous tracheostomy (PT) necessary. However, surgeons must also be prepared to perform OT and urgent cricothyroidotomy under safe conditions should the need arise.

RISKS TO PROVIDERS DURING TRACHEOSTOMY

Tracheostomy poses a significant risk of viral transmission because it is an aerosol-generating procedure.^{6,7} This risk pertains not only to the operating surgeon but to all team members in the room during the procedure. A systematic review estimated the odds of transmission from tracheostomy (OR 4.2) as second only to intubation (OR 6.6).⁶ However, there was a paucity of studies on tracheostomy that prohibited a direct comparison of the procedures. In our opinion, current data vastly underestimate the risk of tracheostomy, in which droplet and blood splatter is virtually guaranteed. Healthcare practitioners performing tracheostomy are an at-risk population. In the 2002 severe acute respiratory syndrome (SARS) epidemic in Toronto, many of those hospitalized with illness were healthcare workers⁸ who were exposed prior to major infection control measures were instituted. In Wuhan, China, 40 of 138 hospitalized patients were healthcare providers who were infected from presumed hospital spread.⁶

With the current pandemic, significant attention has been focused on the safety of healthcare workers, and many organizations have published

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guidance on infection prevention and control for these essential personnel.⁹⁻¹²

CONSIDERATIONS FOR INDICATIONS AND TIMING

Surgeons should consider both short-term and long-term outcomes of tracheostomy along with the risks of exposure of the clinical team. In many cases tracheostomy should be deferred until the patient has ceased viral shedding. In some circumstances, tracheostomy may accelerate ventilator weaning,⁴ which might improve throughput of patients with Covid-19 in the hospital system, making room for new patients if ICU resources and ventilators become scarce. This is important since, depending on the trajectory of the pandemic in the USA, it is projected that the need for ventilators may far exceed the number of devices available, currently estimated at approximately 75 000 including those available in the Strategic National Stockpile¹³ and another 98 000 ventilators that can perform only basic functions.¹⁴

The long-term outcomes after tracheostomy in non-surgical patients are poor, with a 1-year mortality of 46.5% overall and 54.7% for those over age 65 years,¹⁵ and these data may be useful in having goals of care discussions with families. In the absence of large-scale triage, the decision to perform a tracheostomy in a patient with Covid-19 currently should be made on a case-by-case basis and with multidisciplinary input, maintaining a patient-centered and family-centered and caregiver safety-focused approach. It should be emphasized that data on tracheostomy in this population are very limited. Patients with severe disease likely are not physiologically stable enough to undergo the procedure, and patients who are recovering from the disease may benefit from traditional ventilator weaning and liberation strategies. At this time, we recommend against performing tracheostomy in patients with active Covid-19 disease.

We recommend using one of the following strategies

- ▶ Delayed tracheostomy
 - Consider pharmacological pretreatment and perform viral load testing first to confirm non-transmissibility of the disease.¹⁶ If testing is negative for Covid-19, proceed with tracheostomy. While some have recommended using standard precautions after a patient with coronavirus tests negative,¹⁷ full personal protective equipment (PPE) may be prudent unless testing has an acceptably low false negative rate.
- ▶ Not performing tracheostomy
 - Continue standard ventilator weaning until extubation.

THE HIGH-RISK SURGICAL AIRWAY

For urgent cricothyroidotomy, patients are often purposely not paralyzed to avoid removing any residual respiratory drive until a definitive airway is in place. However, in patients with known or suspected Covid-19 infection, risk of wide dissemination and droplet spray on surgical airway entry makes neuromuscular blockade prior to cricothyroid membrane incision justified.

- ▶ Despite the urgency of the situation, it is essential that providers wear appropriate PPE prior to any intervention.
- ▶ Hold ventilation prior to opening the cricothyroid membrane and until placement of the definitive airway.
- ▶ If difficulty is encountered in placing the airway, and the patient needs to be ventilated again by bag-valve mask, occlude the cricothyroidotomy opening with a finger to prevent air leak. Hold ventilation again prior to reattempting placement.

In other high-risk populations such as the very obese, transport to the optimal environment of the operating room is often preferred. If transportation is not desirable because of risk of viral spread, the surgeon should consider the feasibility of performing a safe bedside procedure or delaying the procedure. In all patients with Covid-19 who need a tracheostomy, an acceptable strategy is to wait for the disease to become non-transmissible* prior to performing a high-risk aerosol-generating procedure such as tracheostomy.

*See CDC recommendations for discontinuation of transmission-based precautions.¹⁶

PROCEDURAL GUIDANCE FOR OPEN AND PERCUTANEOUS TRACHEOSTOMY

Here we provide practical guidance for the performance of OT and PT in patients with known or suspected Covid-19 infection. The risk of complications and death are similar between OT and PT, except that stoma site infections are more common with OT.⁴ The choice of OT or PT may be made based on an individual patient's clinical condition, anatomy, the operator's experience with each technique and logistical considerations such as the risk of transportation (if necessary) to the operating room for OT.

Preparation and procedural safety

1. Perform in a negative pressure airborne infection isolation room (AIIR).
 - a. If an AIIR is not available, avoid entry into room by non-essential personnel for up to 3 hours due to persistence of viable virus in aerosols.¹⁸
2. Limit the number of participants in the room to essential personnel only.¹⁹
3. An experienced attending surgeon or other experienced practitioner should perform the procedure.
 - a. Trainees should not be involved unless absolutely necessary¹⁹ to expedite the procedure and avoid unnecessary risk.
4. Post a runner outside the room to aid communication and to obtain new equipment as needed.
5. Take only essential equipment into the room, including an oversupply of any medications that will be needed. Have potentially necessary and backup equipment immediately outside the room.
 - a. It is important to avoid delays or interruptions after starting the procedure due to lack of equipment or sedative medications.
6. Ensure presence of a HEPA viral filter on the ventilator and suctioning equipment.
7. Perform standard hand hygiene and use a double glove technique, which has been recommended to reduce risk of viral transfer during doffing of PPE.²⁰ Wear a fluid-resistant gown. Double gowning has also been recommended by some.²¹
8. Use a powered air purifying respirator (PAPR) with standard donning as recommended by the CDC. Use an N95 mask under the PAPR hood as backup in the event of PAPR mechanical failure.
 - a. According to the CDC, not using a respirator mask during an aerosol-generating procedure upgrades the risk of healthcare personnel from low risk to medium risk.⁹
 - b. According to the Anesthesia Patient Safety Foundation, PAPR is superior to a mask for protection from viral transmission.¹¹

- c. Respirator efficacy is measured by the assigned protection factor (APF). PAPRs used in healthcare typically have an APF of 25, while N95 masks filter 95% of particles and have an APF of 10.²²
 - d. PAPR has been recommended based on experience with the SARS epidemic in Asia.²¹
 - e. During non-procedural situations, in the event of failure of PAPR gear, healthcare personnel are instructed to leave the room immediately since they are no longer protected from airborne viral transmission. Suddenly aborting a tracheostomy procedure at a critical moment could result in airway loss and death. Therefore, we recommend wearing an N95 mask under the PAPR as a backup to allow completion of the procedure should the PAPR fail.
 - f. If situations where a PAPR is not available, personnel should use an N95 or higher mask, along with a fluid shield and full eye protection.
9. Use neuromuscular blockade in addition to full sedation/anesthesia to prevent coughing and resultant particulate spread.
 - a. Routine paralysis has been recommended by practitioners involved with tracheostomy during the SARS outbreak of 2002 in Asia^{21,23} and other specialty societies.²⁴
 10. Fully drape the entire patient and bed to avoid any contamination of the bed, pillow, sheets or equipment.
 - a. Use a double layer of impervious draping to prevent soak-through.
 - b. Place instruments on a flat tray or table instead of on the patient to avoid equipment rolling or falling off the bed.
 11. Place a cuffed, non-fenestrated tracheostomy tube.²⁴ Inflate cuff after placement and check to ensure absence of a cuff leak (see *Technical considerations* for PT and OT below).
 12. Doff PPE as recommended by the CDC.

Technical considerations

Open tracheostomy

- ▶ Avoid electrocautery to prevent aerosolization of viral particles.
- ▶ Stop mechanical ventilation after an exhalation just prior to tracheal entry.
- ▶ Hold ventilation until intratracheal placement of the tracheostomy tube and inflation of the cuff, if the patient's condition will allow (no critical hypoxemia).
- ▶ Resume ventilation through the tracheostomy after cuff inflation.
- ▶ Remove endotracheal tube from the mouth, placing it directly into a plastic bag for disposal.

Percutaneous tracheostomy

- ▶ Use of bronchoscopy
 - a. Bronchoscopy is often used in PT to localize the insertion site, aid visualization and avoid damage to the back wall of the trachea. Bronchoscopy itself is an aerosol-generating procedure and could pose an addition risk of exposure. While there is insufficient evidence that its use decreases the number of complications during tracheostomy,⁴ many surgeons use bronchoscopy as a standard component of the PT procedure. If performing PT in a patient with active Covid-19 infection, surgeons should consider their individual expertise and experience with performing PT without bronchoscopy to decide on its use.
 - b. If available, use of disposable, single-use bronchoscopes is recommended.

- c. If opting not to use bronchoscopy, consider alternative methods to determine withdrawal of the endotracheal tube above the tracheotomy site, including but not limited to:
 1. Palpation with a finger on the trachea while the endotracheal tube is being withdrawn; the surgeon can feel the trachea become softer and more pliable as the tube is withdrawn above the proposed tracheotomy site.
 2. Use of a Doppler over the incision site; when the endotracheal tube is withdrawn above the proposed tracheotomy site, the audible volume from air flow through the end of the tube will be much louder.
 3. Blind placement of the needle, using aspiration of air or bubbles in a fluid-filled syringe to confirm intratracheal placement.
 - ▶ Avoid electrocautery to prevent aerosolization of viral particles.
 - ▶ Stop mechanical ventilation after an exhalation, after placing the guidewire and just prior to tracheal dilation.
 - ▶ Hold ventilation until intratracheal placement of the tracheostomy tube and inflation of the cuff, if the patient's condition will allow (no critical hypoxemia).
 - ▶ Resume ventilation through the tracheostomy after cuff inflation.
 - ▶ Remove endotracheal tube from the mouth, placing it directly into a plastic bag for disposal.

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REFERENCES

- 1 Centers for Disease Control and Prevention. Cases in U.S. <https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/cases-in-us.html> (Accessed March 26, 2020).
- 2 Centers for Disease Control and Prevention. Severe Outcomes Among Patients with Coronavirus Disease 2019 (COVID-19) — United States, February 12–March 16, 2020. https://www.cdc.gov/mmwr/volumes/69/wr/mm6912e2.htm?s_cid=mm6912e2_w (26 Mar 2020).
- 3 Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, Wang B, Xiang H, Cheng Z, Xiong Y, *et al.* Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus-infected pneumonia in Wuhan, China. *JAMA* 2020;323:1061–9.
- 4 Raimondi N, Vial MR, Calleja J, Quintero A, Cortés A, Celis E, Pacheco C, Ugarte S, Añón JM, Hernández G, *et al.* Evidence-Based guidelines for the use of tracheostomy in critically ill patients. *J Crit Care* 2017;38:304–18.
- 5 de Franca SA, Tavares WM, Salinet ASM, Paiva VS, Teixeira MJ. Early tracheostomy in severe traumatic brain injury patients: a meta-analysis and comparison with late tracheostomy. *Crit Care Med* 2020;48:e325–31.
- 6 Tran K, Cimon K, Severn M, Pessoa-Silva CL, Conly J. Aerosol generating procedures and risk of transmission of acute respiratory infections to healthcare workers: a systematic review. *PLoS One* 2012;7:e35797.
- 7 COVID-19 Airway management principles. <https://icmanaesthesiacovid-19.org/airway-management> (19 Mar 2020).

- 8 Booth CM, Matukas LM, Tomlinson GA, Rachlis AR, Rose DB, Dwosh HA, Walmsley SL, Mazzulli T, Avendano M, Derkach P, *et al*. Clinical features and short-term outcomes of 144 patients with SARS in the greater Toronto area. *JAMA* 2003;289:2801–9.
- 9 Centers for Disease Control and Prevention. <https://www.cdc.gov/coronavirus/2019-ncov/index.html> (19 Mar 2020).
- 10 State of California Department of Industrial Relations. Interim guidance for protecting health care workers from exposure to coronavirus disease (COVID-19). <https://www.dir.ca.gov/dosh/Coronavirus-info.html> (19 Mar 2020).
- 11 Anesthesia Patient Safety Foundation. Perioperative considerations for the 2019 novel coronavirus (COVID-19). <https://www.apsf.org/news-updates/perioperative-considerations-for-the-2019-novel-coronavirus-covid-19/> (19 Mar 2020).
- 12 Centers for Disease Control and Prevention. Guidelines for droplet/aerosol room environments. [https://www.cdc.gov/infectioncontrol/guidelines/environmental/background/air.html#5c%20%20\(section%20c\)](https://www.cdc.gov/infectioncontrol/guidelines/environmental/background/air.html#5c%20%20(section%20c)) (19 Mar 2020).
- 13 Halpern NA, Tan KS. the SCCM Ventilator Taskforce. U.S. ICU resource availability for COVID-19. <https://www.sccm.org/Blog/March-2020/United-States-Resource-Availability-for-COVID-19> (19 Mar 2020).
- 14 Johns Hopkins Bloomberg School of Public Health, Center for Health Security. Ventilator stockpiling and availability in the US. <http://www.centerforhealthsecurity.org/resources/COVID-19/200214-VentilatorAvailability-factsheet.pdf> (25 Mar 2020).
- 15 Mehta AB, Walkey AJ, Curran-Everett D, Douglas IS. One-Year outcomes following tracheostomy for acute respiratory failure. *Crit Care Med* 2019;47:1572–81.
- 16 Interim Guidance. Discontinuation of Transmission-Based Precautions and Disposition of Patients with COVID-19 in Healthcare Settings. <https://www.cdc.gov/coronavirus/2019-ncov/hcp/disposition-hospitalized-patients.html> (24 Mar 2020).
- 17 National Tracheostomy Safety Project. <https://www.entuk.org/sites/default/files/files/NTSP%20COVID-19%20tracheostomy%20guidance%20Mar-2020.pdf> (19 Mar 2020).
- 18 van Doremalen N, Bushmaker T, Morris DH, Holbrook MG, Gamble A, Williamson BN, Tamin A, Harcourt JL, Thornburg NJ, Gerber SI, *et al*. Aerosol and surface stability of SARS-CoV-2 as compared with SARS-CoV-1. *N Engl J Med* 2020. [Epub ahead of print: 17 Mar 2020].
- 19 Brindle M, Gawande A. Managing COVID-19 in surgical systems. <https://journals.lww.com/annalsurgery/Documents/Managing%20COVID%20in%20Surgical%20Systems%20v2.pdf> (Accessed March 19, 2020).
- 20 Casanova LM, Rutala WA, Weber DJ, Sobsey MD. Effect of single- versus double-gloving on virus transfer to health care workers' skin and clothing during removal of personal protective equipment. *Am J Infect Control* 2012;40:369–74.
- 21 Kwan A, Fok WG, Law KI, Lam SH. Tracheostomy in a patient with severe acute respiratory syndrome. *Br J Anaesth* 2004;92:280–2.
- 22 Gold D. *Defining PAPRs and current standards: regulatory perspective. in board on health sciences policy; Institute of medicine. The use and effectiveness of powered air purifying respirators in health care: workshop summary.* Washington (DC): National Academies Press (US), 2015:7–18.
- 23 Wei WI, Tuen HH, Ng RWM, Lam LK. Safe tracheostomy for patients with severe acute respiratory syndrome. *Laryngoscope* 2003;113:1777–9.
- 24 Harrison L, Ramsden J, Winter S, Roche J, Heward E. Guidance for surgical tracheostomy and tracheostomy tube change during the COVID-19 pandemic. <https://www.entuk.org/covid-19> (19 Mar 2020).