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# Controversies in Tracheostomy for Patients With COVID-19: The When, Where, and How

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**COVID-19 has impacted how we deliver care to patients, and much remains unknown regarding optimal management of respiratory failure in this patient population. There are significant controversies regarding tracheostomy in patients with COVID-19 related to timing, location of procedure, and technique. In this narrative review, we explore the recent literature, publicly available guidelines, protocols from different institutions, and clinical reports to provide critical insights on how to deliver the most benefit to our patients while safeguarding the health care force. Consensus can be reached that patients with COVID-19 should be managed in a negative-pressure environment with proper personal protective equipment, and that performing tracheostomy is a complex decision that should be made through multidisciplinary discussions considering patient prognosis, institutional resources, staff experience, and risks to essential health care workers. A broad range of practices exist because there is no conclusive guidance regarding the optimal timing or technique for tracheostomy.** *Key words: COVID-19; tracheostomy.* [Respir Care 0;0(0):1–●. © 0 Daedalus Enterprises]

## Introduction

As the COVID-19 pandemic continues to evolve, acute care surgeons, intensivists, and other specialists are faced with unprecedented challenges in the care of these patients. A not-infrequent complication of severe COVID-19 is acute hypoxemic respiratory insufficiency requiring invasive mechanical ventilation. Early data up through February 11, 2020, from the Chinese Center for Disease Control and Prevention identified > 72,000 cases, of which 14% were classified as severe and 5% as critical.[1] A significant portion of patients who fall into the severe and critical categories will require endotracheal intubation and prolonged mechanical ventilation. Some models have put forth

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invasive mechanical ventilation rates up to 15%, but more recent data through early March 2020 from the Chinese National Health Commission showed that approximately 3.2% of patients with COVID-19 required invasive mechanical ventilation at some point in their disease course.[2] While these numbers will continue to fluctuate as our understanding of COVID-19 evolves and testing capabilities improve with the development of novel therapeutics, there remains an undeniable strain on our health care resources and staff from the surge of patients who require prolonged mechanical ventilation. There are controversies regarding when (at 7, 14, or 21 d), where (ICU vs operating room), and how (open vs percutaneous) tracheostomy should be performed on ventilated patients with COVID-19. Relevant articles were identified from PubMed and via Google search using the key words "COVID-19" and "tracheostomy" with cross references. Study types used in our review include professional organization position statements, guidelines, recommendations, institutional protocols, and clinical reports. Non-English articles were not captured in our review. Online content was specifically sought to provide up-to-date information. Our search was completed on May 21, 2020, and a total of 19 papers were identified (Table 1).

## When to Perform Tracheostomy?

Many clinicians believe that patients with respiratory failure should not be on mechanical ventilation via an endotracheal tube for > 3 weeks.[3,4] Traditionally, a tracheostomy is performed to facilitate weaning from ventilator support, to enhance clearance of secretions, to improve patient mobility, comfort and oral hygiene, and to prevent subglottic stenosis.[5] The TracMan study was one of the first multi-center studies to assess tracheostomy timing, and its results indicate that early tracheostomy (< 4 d) was associated with shorter duration of sedation but made no difference in mortality or length of stay in the ICU or hospital.[6] Subsequent studies regarding early tracheostomy have produced similar results.[7,8] The long-term outcomes of tracheostomy in nonsurgical patients are poor, with a 1-y mortality rate of 46.5% overall and 54.7% for those > 65 y old.[9] The challenge lies in our ability to identify which patients are more likely to require prolonged invasive mechanical ventilation and benefit from a tracheostomy, especially in the setting of COVID-19 respiratory failure. Outcomes of patients with COVID-19 requiring intubation have been poor, and a single-center study from Wuhan, China, noted that 67 out of 201 subjects required intubation, of whom 44 (65.7%) died.[10]

To avoid unnecessary tracheostomy, we must consider patients who would recover smoothly without intervention as well as those likely to progress to death. It is important to identify the time points after ICU admission, if any, where patients clinically improve, stay the course, or get progressively worse. Unfortunately, only scarce information is available at this time. A study from the SARS-1 outbreak identified the mean time from symptom onset to hospitalization to be 2–8 d and the mean time from onset of symptoms to death to be 23.7 d.[11] This paper has been widely cited as a factor impacting the decision of delayed tracheostomy. However, the study did not report the time from ICU admission to death or the percentage of subjects requiring mechanical ventilation after transfer to the ICU.[11] Because COVID-19 behaves clinically differently from SARS-1,[12,13] our insights from SARS-1 may not be able to be directly extrapolated to COVID-19. Recently, a study of the COVID-19 epidemic in China identified that the median time from symptom onset to radiologically confirmed pneumonia was 5 d, from symptom onset to ICU admission was 11 d, and from ICU admission to death was 7 d.[14] A multi center study by Grasselli et al[15] reported a median ICU stay of 9 d for subjects with COVID-19 during the COVID-19 outbreak in Lombardy, Italy. All of this evidence suggests a turning point of 7–9 d after ICU admission in patients with COVID-19. This information suggests that there is a low potential benefit of tracheostomy within 7–9 d after ICU admission. However, if a patient survives for > 7–9 d in the ICU, a tracheostomy can be considered if the patient is expected to continue to require invasive mechanical ventilation.

An important factor to take into consideration for the timing of tracheostomy for patients with COVID-19 is the risk of transmission to health care workers. As an aerosol-generating procedure, tracheostomy in the COVID-19 population presents an interesting conundrum. These patients have relatively poor survival rates once on mechanical ventilation, leading to debate of whether the potential benefits are worth the risk of exposure to essential health care workers and the environment. A systematic review estimated a significantly increased odds ratio of aerosol transmission with noninvasive ventilation (odds ratio 3.1), tracheostomy (odds ratio 4.2), and intubation (odds ratio 6.6).[16] In an effort to minimize aerosol generation, tracheostomy is often delayed until the patient's viral shedding has ceased or decreased. Studies into the viral load of COVID-19 in the upper respiratory tract indicate that, like SARS-1, SARS-CoV-2 viral loads are highest in the early parts of the disease with typical clearance by 2 weeks.[17] While viral loads do not correlate well with severity of symptoms, several groups have recommended delaying tracheostomy to allow viral loads to decline and thus reduce the risk of transmission.[18-22]

From our review of available guidelines, timing of elective tracheostomy in patients with COVID-19 can be roughly divided into 3 categories: early (< 14 d), delayed (> 2–3 weeks), and deferred. Eight of the sources recommend either no tracheostomy or deferred tracheostomy until testing is negative for COVID-19.[19,21,23-28] The

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Table 1. List of Publicly Available COVID-19 Tracheostomy Guidelines or Institutional Protocols

| Organization/Institution | Article Type | Duration of Mechanical Ventilation, d | Location | Technique |
|---|---|---|---|---|
| American Academy of Otolaryngology[29] | Recommendation | > 14–21 | NA | NA |
| American Association for the Surgery of Trauma[19] | Guidelines, recommendation | No tracheostomy or delay until negative | Negative pressure, operating room for high-risk patients | No preference |
| Surgical Infection Society[31] | Guidelines | Unknown | Negative pressure | Open |
| New York Head and Neck Society[18] | Recommendation | > 21 | Negative pressure, bedside > operating room | No preference |
| New York University[21] | Recommendation | No tracheostomy or > 14 | Negative pressure | No preference |
| New York University-Langone Percutaneous Tracheotomy Protocol[34] | Institutional protocol | > 5–7 | Negative pressure, bedside | Percutaneous |
| New York University-Langone[33] | Clinical report | 10.6 | NA | Modified percutaneous |
| University of Pennsylvania Tracheotomy Task Force[30] | Institutional protocol | > 21 | Negative pressure, bedside > operating room | Open |
| University of Pennsylvania Tracheostomy Procedure Guideline[39] | Guidelines | > 10–14 | Negative pressure, bedside > operating room | No preference |
| Michigan Medicine Tracheostomy Guidelines[23] | Guidelines | Delay, until negative | Negative pressure, bedside > operating room | No preference |
| Lake Erie College and Medical University of South Carolina[24] | Clinical protocol | Delay, until negative | Negative pressure, bedside > operating room | NA |
| University of California San Francisco[10] | Guidelines | > 14–21 | Negative pressure, bedside > operating room | No preference |
| University of California Los Angeles[20] | Recommendation | Delay, unspecified | Negative pressure, bedside > operating room | Percutaneous |
| ENT United Kingdom[26] | Guidelines | Delay, until negative | Negative pressure, bedside > operating room | NA |
| National Tracheostomy Safety Project[28] | Guidelines | Delay, until negative | Negative pressure, bedside > operating room | NA |
| United Kingdom[22] | Recommendation | > 14 d | Negative pressure, bedside > operating room | No preference |
| National University of Singapore[38] | Recommendation | NA | Negative pressure, bedside > operating room | Open |
| University Hospital of Modena, Italy[32] | Clinical report | 7–14 | Negative pressure, bedside for perc | No preference |
| Brazilian Association of Otolaryngology and Cervicofacial Surgery Position Statement[27] | Position statement | No tracheostomy | Negative pressure | NA |

NA = not applicable

National Tracheostomy Safety Project recommendations did highlight potential benefits of earlier tracheostomy including reduced sedative use and a 'sealed' system that may be preferable to high flow oxygen therapy.[28] The Michigan Guidelines recommend 2 negative SARS-CoV-2 tests separated by 24 h and resolution of fever and symptoms prior to tracheostomy.[23] Five papers recommend delaying tracheostomy to 2–3 weeks after intubation.[18,20,26,29,30] The common reasoning is that this allows viral loads to decrease and minimizes the risk of transmission. The Surgical Infection Society Guidelines did not provide recommendations regarding tracheostomy timing but acknowledged the controversy and lack of clinical data to guide best practices.[31] These studies all agreed that preoperative SARS-CoV-2 testing was important to inform best practices to protect health care workers, although positive status was not enough to halt tracheostomy if a clinical benefit was perceived for the patient.

RESPIRATORY CARE Paper in Press. Published on September 1, 2020 as DOI: 10.4187/respcare.08100



Thus far, there are minimal clinical data to recommend for or against an early tracheostomy in ventilated patients with COVID-19. Mattioli et al[32] from Italy recommend against tracheostomy within the first 7 d due to patient instability during the early course; however, patients anticipated not to reach weaning targets within 7–14 d were considered for tracheostomy. The authors performed 28 nondelayed tracheostomies with no reports of transmission to the health care team.[32] Another group performed modified percutaneous dilational tracheostomy (PDT) with a mean time of 10.6 d from intubation to procedure.[33] They reported bedside PDT on 98 subjects with COVID-19 respiratory failure from March 10 to April 15, 2020. By the time their manuscript was submitted on April 19, 2020, 41% subjects remained on mechanical ventilation, 19% had been actively weaning, and 33% had been completely liberated from the ventilator; only 7% of their subjects died after tracheostomy due to respiratory and multiple-organ system failure.[33] The protocol from NYU Langone Healt,[34] available online now, tries to identify patients 5–7 d post-intubation as eligible for PDT.

### Where to Perform Tracheostomy and Technique

Regarding the site for performing tracheostomy, a negative-pressure environment is of paramount importance, as noted in all guidelines that address location. The importance of a negative-pressure environment was explicitly addressed by all organizations and institutions except for the American Academy of Otolaryngology and ENT United Kingdom.[26,29] All of these papers noted that, if a negative-pressure environment was available in the ICU, performing tracheostomy at the bedside in the ICU was preferable to the operating room to remove the risk of transmission during patient transport. Performing tracheostomy within the ICU avoids unnecessary patient transport and repeated disconnection and reconnection of ventilatory circuits. COVID-19 viral particles within aerosols were found to be viable past 3 h, and viral particles were demonstrated to be viable on plastic and stainless steel surfaces up to 72 h after application.[35] The primary virtues of performing tracheostomy in the operating room are better visualization, improved ergonomics for providers, and availability of equipment and instruments to deal with operative contingencies, especially in a patient population with a disease as complicated as COVID-19. High-risk patient populations, such as the very obese, those with a short neck, or those with an enlarged thyroid, may benefit from transport to an operating room.[32] However, decontamination of an operating room may pose a challenge for institutions with limited operating room availability; therefore, performing tracheostomy at the bedside may provide a more efficient use of facility resources. Several groups have highlighted the benefits of PDT, including the ease with which it can be performed at the bedside in the ICU.[22,25,33]

The recommendations regarding PDT versus open/surgical tracheostomy are less clear cut. Despite many studies comparing surgical tracheostomy and PDT, there remains no consensus on which is more advantageous in critically ill patients. A literature review with specific regard to mortality and intra- and postprocedural bleeding did not show any statistically significant difference between the 2 approaches.[36,37] Uncertainty remains about whether PDT generates significantly more aerosol than surgical tracheostomy. A large portion of the surgical tracheostomies performed during the SARS outbreak described in the literature were performed at the bedside in a negative-pressure ICU room.[38] No transmission to health care workers was reported, which was largely attributed to the proper use of personal protective equipment; however, they speculated that PDT may present higher risk due to more extensive airway manipulation (eg, bronchoscopy and serial tracheal dilations), a viewpoint that is shared by the University of Pennsylvania Task Force and the Surgical Infection Society.[30,31] Bronchoscopy is known as an aerosol-generating procedure, and the pooled estimate from 2 studies of the odds ratios of aerosol transmission with bronchoscopy was 1.9.[16] However, proponents of PDT have pointed to decreased epithelial trauma and lower operative times as ways to minimize the likelihood of exposure.[25] When performing PDT, one should consider using anatomic landmark-based or ultrasound-guided techniques instead of a bronchoscopic-guided, dilational tracheostomy because the 3 PDT techniques are comparable with respect to associated procedure-related complications, according to a network comparative meta-analysis.[37] An alternative approach is a technique proposed by Angel et al,[33] in which the bronchoscope is passed adjacent to the endotracheal tube without passing the inflated cuff to minimize exposure of viral particles. PDT may be a preferable option if the risk of aerosol generation can be reduced by these modifications and it facilitates performance of the procedure at the ICU bedside.

Many of the reviewed articles deferred choice of technique to the familiarity of the surgeon and the availability of resources. Ultimately, the final decision regarding where and how tracheostomy is performed will vary between institutions and will depend on patient factors, facility resources, and local expertise.

### Summary

There is universal agreement that tracheostomy in patients with COVID-19 is associated with increased risk of viral transmission. Proper use of personal protective equipment is essential to the management of these patients, and care should be administered in a negative-pressure

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environment if available. Emergent tracheostomy should still be performed in life-saving situations, but adjustments to intraoperative practice have been suggested, such as apnea prior to making the tracheostomy and utilization of paralytics to minimize opportunities for exposure. Controversy remains regarding optimal timing, location, and technique for elective tracheostomy in ventilated patients with COVID-19. While generally performed 2–3 weeks after intubation, as recommended by several groups, tracheostomy can be performed safely with regard to patients and health care workers as early as 7–9 d after intubation, even if the patient still tests positive for SARS-CoV-2. Currently there are no data to identify the best location and technique for the procedure, but tracheostomy can be performed safely in either the ICU or the operating room with the surgeon's choice of technique. The decision regarding these issues is complex and should be made through multidisciplinary discussions considering patient prognosis, risk and benefits for the patients, institutional resources, staff experience, and risks to essential health care workers.

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