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32 **Introduction**

33 The acceleration of the Coronavirus Disease 2019 (COVID-19) pandemic has led
34 to unprecedented challenges for the medical community, including the need to
35 expand our healthcare resources to care for a surge of patients requiring
36 intensive care. The experience in Wuhan suggests that approximately 5 to 10%
37 of COVID-19 patients require intensive care unit (ICU) admission, with a
38 percentage of those patients requiring mechanical ventilation[1 2]. A subset of
39 patients on prolonged mechanical ventilation may require open tracheotomy.
40 Indeed, while operative procedures on Severe Acute Respiratory Syndrome
41 (SARS) patients were uncommon during the 2003 outbreak, open tracheotomy
42 was the most common surgical procedure performed in patients with SARS[3].
43 For example, among the 238 people infected with SARS in Singapore, fifteen out
44 of 41 surgical procedures performed were tracheotomies.

45
46 Performing a tracheotomy on a COVID-19 patient is high risk for transmission of
47 COVID-19 to health care workers because it is an aerosol-generating procedure.
48 Growing consensus among otolaryngologists is to delay tracheotomy until the
49 prognosis of the patient is more clearly defined, likelihood of recovery is high,
50 and viral load is reduced[4]. While viral shedding patterns of COVID-19 remain to
51 be elucidated, preliminary data suggests that COVID-19 shedding resembles that
52 of Influenza with a peak early in its clinical course, compared with the later viral
53 shedding observed in SARS that peaked approximately ten days after symptom
54 onset[5 6]. Decisions on the timing of tracheotomy in ICU patients on mechanical

55 ventilation are often challenging and must be individualized including consultation
56 with family and consideration of patient wishes. However, we agree with the
57 general guideline that otolaryngologists delay tracheotomy in COVID-19 patients
58 until risk of death has plateaued and risk of viral shedding has declined.

59

60 Limited reports of tracheotomy on patients infected with SARS highlight
61 successful tracheotomy protocols that can serve as a guideline for COVID-19
62 patients[3 7-9]. It is worth noting that among 21 tracheotomies performed on
63 patients with SARS in Singapore, Hong Kong, and Canada, no known members
64 of the surgical team became infected. We wish to emphasize several important
65 points:

- 66 1. Utilization of appropriate personal protective equipment (PPE) is
67 paramount. Standard PPE may differ by institution, but at a minimum
68 should include an N95 mask and eye protection or powered, air-purifying
69 respirator (PAPR), waterproof gown, surgical cap, and two sets of gloves.
70 Limitations of PAPR should be considered and include limited availability,
71 reduced ability to hear communication during the procedure and inability
72 to wear a headlight
- 73 2. When possible, tracheotomy should be performed in a negative pressure
74 ICU room to avoid transporting patients through the hospital to the
75 operating room.

- 76 3. Open tracheotomy is preferred to percutaneous tracheotomy in order to
77 limit the time of aerosolization and exposure to viral load related to
78 bronchoscopy that is required for the percutaneous procedure.
- 79 4. Every effort should be made to limit the number of personnel in the room
80 and to limit exposure time by having the most experienced operators
81 available perform the procedure.

82

83 Utilization of a surgical safety checklist was popularized in 2008 based on
84 evidence that implementation of a checklist was associated with significant
85 reductions in the rates of death and complications among surgical patients[10].
86 Since that time, the use of surgical safety checklists has become mainstream
87 and standardized throughout the United States and globally[11]. Indeed, a recent
88 review of 1464 facilities in 94 countries found that a surgical safety checklist was
89 used in 75.4% of operations[12]. Over the last decade, a multitude of studies
90 have aimed to evaluate the efficacy of surgical safety checklists in reducing
91 perioperative complications in various settings, including during emergency
92 procedures, and with varying results[13-15]. There continues to be active debate
93 regarding whether the benefits observed in checklist studies are attributable to
94 the checklist itself or to specific elements embedded in the checklist (e.g. more
95 consistent use of perioperative antibiotics). Further, some have proposed that the
96 benefits of checklists are attributable to the improved teamwork and
97 communication that typically accompanies checklist implementation.

98

99 Given the high acuity setting of performing tracheotomies in COVID-19 patients,
100 we believe that utilization of a checklist will be beneficial as a communication tool
101 and will aid teams in rehearsing the procedure ahead of time in a lower risk
102 setting in order to anticipate institution-specific challenges. To that aim, we wish
103 to share our institution's surgical safety checklist for performing tracheotomy in
104 COVID-19 patients. In doing so, we hope to facilitate adoption of these important
105 modifications by the otolaryngology community and to continue the discussion on
106 further steps that can be taken to mitigate these risks. Key points of emphasis
107 within our checklist include proper donning and doffing of PPE and steps directed
108 towards reducing the risk of viral aerosolization including the use of paralysis to
109 prevent coughing, stoppage of ventilation while opening the airway and
110 avoidance of suctioning if at all possible.

111

112 **Conclusions**

113 Performing a tracheotomy on a COVID-19 patient is a procedure that carries high
114 risk to health care workers due to close contact with aerosolized viral particles.
115 Evidence from the SARS outbreak demonstrates that important modifications to
116 the tracheotomy procedure can substantially reduce the risk to health care
117 workers. Here we share our institution's surgical safety checklist for performing
118 tracheotomy in COVID-19 patients. In doing so, we aim to facilitate adoption of
119 these important modifications by the otolaryngology community and to continue
120 the discussion on further steps that can be taken to mitigate these risks.

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COVID-19 TRACHEOTOMY CHECK LIST

Surgical Equipment

- Standard tracheotomy tray
- Scalpel blades #11 and #15
- Cautery unit
- Grounding pad
- Bovie and bipolar cautery instruments
- Cuffed non-fenestrated tracheotomy tubes in a variety of sizes. At our institution, this includes Shiley sizes 4, 6, and 8 for most patients.
- Endotracheal tubes sizes 6 and 7
- Tracheal suction catheter, suction cannister and tubing
- Local anesthetic
- Two 2-0 Silk sutures, one to secure tracheostomy tube to skin and one available if needed for bleeding control or airway retraction
- Tracheostomy ties
- Povidone-iodine surgical scrub
- Surgical drapes and towels
- Two portable headlights with battery pack

Surgeon Personal Protective Equipment

This will vary by institution and may evolve as our knowledge of transmission patterns evolves. At our institution for aerosol-generating procedures, this includes:

- N95 mask and eye protection
- Alternative PPE includes powered air-purifying respirator (PAPR) with potential limitation in the ability to use headlight
- Waterproof gown
- Surgical cap
- Two sets of gloves
- Shoe covers

Procedure steps

1. Perform time out prior to donning PPE and entering room.
2. Surgeons dons PPE as recommended by institution. **We recommend donning inner gloves prior to gown and donning outer gloves after gown. This allows one to remove gown and outer glove at once while maintaining clean inner gloves to be used for removal of remaining PPE at end of procedure [16].**
3. Set up equipment. Check that all instruments are present. Check that cautery and headlights are functional. Test tracheostomy tube balloon.
4. Anesthesiologist fully sedates and paralyzes patient. This is very important to minimize cough reflex.

5. Inject local anesthetic into skin, if desired. **Do not inject local anesthetic into airway to avoid triggering cough.**
6. Perform povidone-iodine prep.
7. Apply surgical drapes.
8. Make skin incision and begin tracheotomy procedure.
9. Once down to anterior trachea and just before airway entry, confirm that anesthesia is ready to perform next key steps.
10. Pre-oxygenate to optimize saturations during apneic time.
11. **Stop ventilation.**
12. Anesthesiologist deflates balloon and advances endotracheal tube to bring deflated balloon just below tracheal incision location. **Maintain no ventilation.**
13. Perform tracheal incision. The surgeon can consider a single horizontal intercartilagenous incision with optional inferior cartilage split to maximize speed. **Limit suctioning as much as possible to reduce aerosolization.**
14. Anesthesiologist removes endotracheal tube until tip of tube is superior to airway incision.
15. Insert tracheostomy tube and inflate cuff.
16. Connect circuit.
17. Resume ventilation and confirm end tidal carbon dioxide return.
18. Secure tracheostomy tube to skin and with ties based on surgeon preference.

19. Anesthesiologist completely removes endotracheal tube and places in biohazard bag.
20. Dispose of sharp instruments in appropriate container. Place disposable instruments in biohazard bag.
21. Place non-disposable instruments in sterilization tray and place tray into biohazard bag.
22. Surgeons doff PPE and exit room. **Remember to use clean inner glove already in place to remove surgical cap, eye protection, and shoe covers.**