

Narrative Review of Tracheostomy Procedure during COVID-19 Pandemic

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Abstract

The COVID-19 pandemic has led to an unprecedented increase in the number of critically ill patients requiring mechanical ventilation. Tracheostomy played an important role to wean off the patients from ventilator support and maximize the resources. Tracheostomy is an aerosol generating procedure (AGP) which raised some controversial issues as it carries a risk of infection to healthcare workers. This study aims to review the issues related to tracheostomy procedure in COVID-19 patients, including the appropriate time to perform tracheostomy, criteria for patient selection, safer approach and risk of infection among healthcare workers. Related information retrieved via online search of original articles, paper reviews, recommendations and guidelines from PubMed, Medline and Google Scholar using keywords *tracheostomy*, *COVID-19*, *intensive care and mechanical ventilation* are summarized in this article. The suggested time frame to perform tracheostomy ranged from 7 to 21 days. Early tracheostomy performed between day 10 to 14 had beneficial outcome for the patients and helped to reduce ICU occupancy. Decision for appropriate timing was made after considering the viral load and the course of the disease. Criteria for patient selection based on suggestions from studies and guidelines were lower oxygen requirement ($FiO_2 < 0.4$, $PEEP < 10$),

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low Sepsis Related Organ Failure (SOFA) scores, ventilation for at least 10 days and signs of improvement. Patient factors, availability of facilities and expertise were important criteria for decision to undertake tracheostomy. The patient outcomes from tracheostomy varied between centers. Most of the studies reported that none of the healthcare workers had been infected by utilizing appropriate PPE and by taking important precautions during the procedure. In conclusion, guidelines were established for tracheostomy procedure during COVID-19 but the decision to undertake the procedure still depend on a case by case basis.

Keywords: *tracheostomy, COVID-19, intensive care, mechanical ventilation*

1. Introduction

Coronavirus Disease 2019 (COVID-19) which is caused by Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) was first identified in Hubei China in December 2019 and has rapidly spread worldwide (Guan et al., 2020). Due to the rapid increase in the number of cases globally, the World Health Organization (WHO) declared the COVID-19 as a pandemic in March 2020 (WHO, 2020a). Up to November 2020 about 55.6 million COVID-19 cases have been reported with 35.8 million cases recovered and 1.34 million deaths.

The presentation of patients infected with SARS-CoV-2 varies from asymptomatic, mild to severe illness. Most of the young and healthy patients were asymptomatic or presented with mild to moderate illness and recovered without requiring any treatment. However, high-risk patients especially elderly with multiple co-morbidities such as diabetes, hypertension, chronic respiratory disease and immuno-compromised conditions usually presented with severe symptoms which required special treatment and admission to intensive care unit (ICU). Since the rapid increase of COVID-19 cases globally, health facilities and health care workers have been overwhelmed by the large numbers of emergency visits, hospitalizations and intensive care admissions (Giacomo et al., 2020). Abate et al. reported from their systematic review about 32% of COVID-19 patients were admitted to ICU (Abate et al., 2020). The increasing number of COVID-19 admissions to ICU will overload the work burden of medical professionals and they are faced with the difficult situations to manage many critically ill patients.

Elective tracheostomy is a common procedure performed for ICU patients to wean them off from mechanical ventilation thereby allowing for availability of ICU beds. Tracheostomy is indicated for patients on prolonged ventilation to prevent complications due to orotracheal ventilation such as tracheal stenosis, and for management of secretions. However, tracheostomy surgery is an aerosol generating procedure (AGP). Thus, during COVID-19 pandemic, healthcare workers involved in undertaking the procedure are at risk of exposure to SARS-CoV-2 transmission. The risk of infection does not only pertain to the operating surgeon but it also involves all team members in the procedure room and post-operative care team. SARS-COV-2 virus have been known to be transmitted through droplets and fomites. Hence there is a potential risk of virus transmission via miniscule aerosols during various medical procedures causing airborne transmission (WHO, 2020b; Bourouiba, 2020; Doremalen et al., 2020; Wang W. et al., 2020). "Airborne transmission" refers to transmission of infection via small (< 5-10um) inspirable aerosols over extensive distances, whereas "droplet transmission" refers to transmission of infection by (larger) aerosols over short distances directly from the infected person to the susceptible person (Tellier et al., 2019; Jones & Brosseau, 2015).

In view of the controversial issues regarding tracheostomy procedure in COVID-19 patient, the surgical team need an appropriate and careful plan to ensure staff safety and patient benefits. The purpose of this review is to collate information from available guidelines and recommendations and retrieve relevant information from original studies regarding the optimal timing to perform tracheostomy, criteria for patient selection, information regarding the approach, important steps and precautions during the procedure, post-operative care and patients' outcome.

2. Methodology

We performed a narrative review of the issues related to tracheostomy procedure in COVID-19 patients which included the appropriate time to perform tracheostomy, criteria for patient selection, approach for tracheostomy procedure, precautions during procedure, post-operative care, patient's outcome and risk of infection among healthcare workers. Relevant information was retrieved via online search of original articles, paper reviews, recommendations and guidelines from PubMed, Medline and Google Scholar using the keywords *tracheostomy, COVID-19 or SARS-COV-2, intensive care and mechanical ventilation*. Full articles including recommendations, guidelines, reviews and original studies published in English were obtained and reviewed. All the relevant information were retrieved, reviewed and summarized.

3. Results

Timing of Tracheostomy

Timing to perform tracheostomy was deliberated even before the COVID-19 pandemic. There were unclear definitions for early and late tracheostomy with poor prediction of patients who will require long-term ventilation. Definitions of early and late tracheostomy were inconsistent among authors resulting in some overlap between the categories. Early tracheostomy is defined as intubation of patient 10 days or less, while late tracheostomy is defined as more than 10 days (Andriolo et al., 2015). Randomized data from Terragni et al. (2010) suggested that earlier tracheostomy (within a mean of seven days after intubation) resulted in early weaning from the ventilator and shorter ICU stay. However, there was no difference in terms of 30-days mortality compared with late tracheostomy (Terragni et al., 2010).

For COVID-19 patients, several factors need to be considered before deciding the appropriate timing to do tracheostomy. The factors include risk of infection to the healthcare workers, viral load and the disease progression. The patient's viral load reduces with time and this decreases the risk of infectivity. The median time from SARS-CoV-2 exposure to onset of symptoms is approximately five days (range 4–14)(Guan et al., 2020; Wang D. et al., 2020). SARS-CoV-2 viral load or infectivity is normally high around the time of onset of symptoms, as shown by polymerase chain reaction (PCR) test of viral radionucleic acid (RNA) from upper respiratory tract sample. The viral load showed decreasing numbers three to four days after onset of symptoms (Zou et al., 2019). Therefore, the authors suggested to delay tracheostomy until after day ten when the viral load starts to decrease. Delaying the tracheostomy also allows for the patient to be observed further so that patients with high probability of survival will be selected for tracheostomy to avoid unnecessary procedure (Hamilton, 2020). This factor is important since unnecessary tracheostomy in COVID-19 patients will increase the risk of exposure to healthcare workers. Delayed tracheostomy patients are more stable and are able to withstand the critical issue of apnea or hypoxia period, which occur during the tracheostomy procedure.

Delayed tracheostomy, however, may deprive the patient therapeutic window and this may lead to complications due to prolonged orotracheal intubation. Moreover, continuous increase in number of COVID-19 cases overwhelms the ICU occupancy and bed availability. Thus, some centers would still consider opting for early tracheostomy that may help in early weaning of ventilation and earlier discharge of patients from ICU. Hence, the appropriate or optimal time for tracheostomy procedure still depends on case-by-case basis and the center's guidelines. Surgeons need to consider potential risks and benefits for the individual patient, risk of exposure to healthcare workers and availability of resources.

Based on past experience from MERS and SARS-CoV, during the early phase of COVID-19 pandemic most of the guidelines and recommendations suggested to delay tracheostomy procedure till 21 days post intubation. Ministry Of Health (MOH) Malaysia also suggested to perform tracheostomy after 20 days post intubation in confirmed COVID-19 patients. There will be an exclusion in the case that tracheostomy cannot be delayed, whereby it will be done within 20 days with adequate PPE (Ministry of Health, 2021). However, when the number of cases and requirement for ICU admission increased, the practice was changed in some centers to perform tracheostomy either less than 10 days or between 10 to 14 days. Various studies reported different timing for performing tracheostomy with inconsistent outcomes. The studies and findings are summarized in Table 1.

Patient Selection and Indications

During the early phase of COVID-19 pandemic, the literature reported that most of the ventilated patients had poor prognoses with few numbers of survival and successful extubation (Yang et al., 2020; Zhou et al., 2020). Studies from United States reported that patients who required ventilation had 88% mortality rate (Richardson et al., 2020). However, there were reports of a few groups of ventilated patients who were able to survive up to 31 days which suggested that these patients may benefit from tracheostomy procedure to facilitate weaning from the ventilators (Fan et al., 2020). A study reported that among non- COVID-19 patients who underwent tracheostomy after prolonged ventilation, at least half of them did not survive for more than 1 year and less than 12% were functionally independent (Vargas & Servillo, 2020). The same may be true for COVID-19 patients; tracheostomy may not always benefit cases on prolonged ventilation. Identification and selection of patients for tracheostomy among COVID-19 patients are challenging decisions for the clinicians. They need to weigh between the patient's short and long-term benefits and outcomes. Besides, the risks of transmission of infection among healthcare staff need to be considered. Thus, prognostic survival indicators is one of the criteria that should be considered in the evaluation of patient selection for tracheostomy.

Mattioli F et al. (2020) suggested that tracheostomy should be performed in patients still distant from the weaning target after day seven. However, there was a lack of data regarding this practice. High SOFA (Sepsis related Organ Failure Assessment) scores can be used as additional critical outcome scores to identify those COVID-19 patients who are too ill to benefit from further interventional procedure (Vincent et al., 1996). Volo T et al. (2020) also suggested that for patients with high SOFA scores of more than 6 and D-Dimer levels more than 4, tracheostomy should be avoided or postponed. Prabhakaran et al. (2020) performed tracheostomy in selected patients with 14 days of intubation and minimal extrapulmonary disease, were hemodynamically stable without acceleration of cytokine storm, projected post tracheostomy ventilation and survival for another

two weeks and no longer requiring the prone position. Reduced requirement for oxygenation such as low FiO₂ (< 0.4-0.6) and positive end-expiratory pressure less than 10-12 cmH₂O is one of the selection criteria for tracheostomy (Breik et al., 2020; David et al., 2020; Ward & Collier, 2020). Most of the authors also suggested that patients who are unlikely to require the prone position more than 72 hours as a criterion for tracheostomy. The prone position might cause dislodgement of the tracheostomy tube. Other additional criteria that have been suggested include normal lymphocytes count and normal coagulation profile (Breik et al., 2020; Ward & Collier, 2020).

The above criteria can be used as a reference to guide surgeons or intensive care doctors when selecting patients for tracheostomy. However, the final decision will depend on patient-to-patient basis and the agreement of the surgical team.

Table 1: Summary of study findings on different timing and outcomes of tracheostomy

| Study | Method | Duration | n | Timing for tracheostomy and outcomes |
|--|--|------------------|----|--|
| Chao et al., Sept 2020 (Philadelphia, Pennsylvania) | Prospective multi-center observational cohort | Not mentioned | 53 | <p>Time: The average time of intubation before tracheostomy was 19.7 (SD= 6.9) days with a range of 8–42 days</p> <p>Outcome:</p> <ul style="list-style-type: none"> - Thirty (56.6%) patients were liberated from the ventilator after tracheostomy - Of these patients, the average time of intubation before tracheostomy was 17.5 (SD= 4.9) days (range 8 – 30 days) - 16 (30.2%) patients have been discharged alive |

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|--|---------------|---|-----|--|
| Bassily-Marcus et al. Aug, 2020 (New York) | Retrospective | 1 month (1 – 30 April, 2020) | 111 | Time: Median time from trans- laryngeal intubation to tracheostomy was 11 days. Outcome: - 66 (59%) patients were discharged alive - 41 (37%) patients expired - Remaining four (4%) patients were weaned from mechanical ventilation but still hospitalized |
| Volo et al., Jul, 2020 (Italy) | Retrospective | 2 months (22 Feb - 26 April 2020) | 23 | Time: The average time between the intubation date and the tracheostomy date was 13 days. Outcome: - The mortality rate of COVID-19 patients admitted to ICU that underwent tracheostomy was 18% - 6 (66.7%) tracheostomies were performed early and 3 (33.3%) late (early ≤ 10 days of intubation, late > 10 days of intubation) |

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|--|-------------|--|-----|---|
| Breik et al., August, 2020 (United Kingdom) | Prospective | 1 month 10 days (9 March- to 21 April 2020) | 100 | <p>Time:</p> <ul style="list-style-type: none"> - Nine patients underwent tracheostomy before 10 days, - 55 between 10 and 14 days - 36 after 14 days of intubation. <p>Outcome:</p> <ul style="list-style-type: none"> - There was no difference in survival between those undergoing tracheostomy before or after day 10 (11% vs 15%, respectively), or before or after day 14 (19% vs 12%, respectively). - Findings also suggest that tracheostomy at 14 days compared to tracheostomy at >14 days, was associated with shorter periods of ventilation and ICU stay |
| Glibbery et al. August, 2020 (United Kingdom) | Prospective | 2 months 5 days (15 March - 20 May 2020) | 28 | <p>Time:</p> <ul style="list-style-type: none"> - The mean time from intubation to tracheostomy formation was at 17.0 (SD 4.4) days, with a range of 8-26 days of mechanical ventilation; - 19 (67.9%) tracheostomies performed after day 14 |

| | | | | |
|--|----------------------------|-----------------------------------|------|---|
| | | | | <p>Outcome:</p> <ul style="list-style-type: none"> - The mortality rate for patients who underwent tracheostomy was 7.1 per cent - Patients who did tracheostomy on day 14 or earlier had earlier weaning from mechanical ventilation, decannulation and intensive care unit stepdown compared to tracheostomy done after day 14 <p>≤ 14 days: mean time from intubation to weaning from mechanical ventilation, decannulation and intensive care unit discharge was 22.2 (SD= 5.4) days, 24.9 (SD= 4.6) days and 27.7 (SD= 7.2) days, respectively.</p> <p>> 14 days: mean time from intubation to weaning from mechanical ventilation, decannulation and intensive care unit discharge was 33.6 (SD= 12.5) days, 36.0 (SD= 12.4) days and 39.7 (SD= 13.4) days, respectively</p> |
| Martin-Villares et al. August 2020 (Spain) | Prospective (120 hospital) | 1.5 months 28 March- 15 May, 2020 | 1890 | <p>Time:</p> <ul style="list-style-type: none"> - 4.6% of COVID-19 patients (88 of 1890 patients) underwent tracheostomy at a very early stage within 7 days - The median time of tracheostomy was 12 days after intubation; (range 4-42 days) |

| | | | | |
|---|--------------------|-----------------------------|-----|---|
| | | | | <p>Outcome: (1616 /1890 patients were on follow up)</p> <ul style="list-style-type: none"> - The overall COVID-19-associated mortality at the time of reporting was 23.7% (n=383/1616) - 24.2% (n=391/1616) were still under mechanical ventilation at the cut-of time - 52.1% (n=842/1616) of patients undergoing tracheostomies weaned off the ventilator with decannulation achieved about 81% (n=683/842) |
| Hamilton, September 2020 (United Kingdom) | Prospective survey | 1 month 6 April - 11 May | 564 | <p>Time:</p> <ul style="list-style-type: none"> - 82% cases performed at 10 days or more and 69% of cases 14 days and more <p>Outcome:</p> <ul style="list-style-type: none"> - Mortality rate 12% (n=62/530) - 52% (n=219/465) alive and weaned off from ventilation - 38% (n=169/450) discharged from intensive care |

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|-------------------------------------|---------------|--|----|---|
| Botti et al. Oct 2020 (Italy) | Retrospective | 2 months 1 March - 30 April 2020 | 44 | Time: - Median time from orotracheal intubation to surgery was 7 (range 2-17) days Outcome: - Fifteen (34.1%) patients died during the follow-up period - Mean duration of ICU stay for tracheostomy patient was 22 days (range 10-67) |
|-------------------------------------|---------------|--|----|---|

Approach for tracheostomy procedure: Surgical versus Percutaneous

In terms of approach to perform tracheostomy, both surgical tracheostomy (ST) and percutaneous tracheostomy (PT) have their own advantages and disadvantages. Kidane et al., 2018 compared ST and PT before the COVID-19 pandemic showed that PT had less complications compared to ST. They also found out that ST had more risks for tracheal stenosis and scarring.

However, there are insufficient clinical trials comparing the two procedures during the COVID-19 pandemic. Nevertheless, data about air sampling during ST and PT are not available from the literature. Chiesa-Estomba et al., (2020) reported from their systematic review of guidelines for tracheostomy in COVID-19 patients showed that six guidelines did not specify the types of tracheostomy recommended, three guidelines recommended open, one recommended percutaneous and six recommended for both (Chiesa-Estomba et al., 2020).

Choices for types of tracheostomy used during COVID-19 pandemic depends on the individual patient’s clinical condition, surgeons’ experience or expertise and the availability of facilities. The operator will choose the approach that is convenient to them to secure the airway while considering the patient’s and staff’s safety. In centers that have intensivist expertise, they will use PT as an approach because it can be performed at the bedside. Time consumption for PT is relatively less compare to ST (Freeman et al., 2001). However, if the patient’s condition does not permit due to obesity with thick neck, presence of thyroid mass or swelling or high risk of bleeding, ST is preferred. PT also requires a special kit and it is quite costly in certain centers (Botti et al., 2020).

PT requires extensive airway manipulation as it involves multiple serial dilatations with bronchoscopic assistance during entry of the trachea, and this exposes the surgeon in direct contact with the patient’s airway. These steps increase the aerosolisation risk compared to ST (Homer et al., 2005; Chee et al., 2004). Bronchoscopy is often used in PT to help in identifying the insertion site and avoiding penetration to the posterior tracheal wall. However, there is lack of evidence to suggest that its use will decrease the number of complications during tracheostomy (Raimondi et al., 2017).

Listed in Table 2 are some of the suggested guidelines for bronchoscopy that can be applied during the COVID-19 pandemic (Michetti et al., 2020):

Table 2: Proposed guidelines for bronchoscopy

| Proposed guidelines |
|--|
| 1. Experienced operators try to avoid using the bronchoscope. They can palpate and feel the trachea using the fingers while the endotracheal tube (ETT) have been withdrawn or place the needle blindly using aspiration of air or bubbles in a fluid-filled syringe |
| 2. Replace bronchoscope with ultrasound guided dilatation which most have reported as non-inferior to bronchoscopic techniques |
| 3. If available, try to use disposable or single-use bronchoscopes. |
| 4. If bronchoscope is needed, advance the ETT distally near carina with the cuff inflated and the bronchoscope is inserted along the side of ETT to minimize aerosolisation and to guide percutaneous puncture |

Bassi et al. (2020) concluded that both PT and ST could be performed safely with minimal aerosolisation spread if the suggested precautions are strictly followed. Surgeons should pay attention to the important particular steps suggested to reduce the time of exposure to aerosol.

Precautions during tracheostomy procedure

Surgeon and staff who are involved in performing the tracheostomy need to take extra precaution before, during and after the procedure. It is essential for each center to have their own dedicated team to perform tracheostomies during the COVID-19 pandemic since the group's experience and training will help to shorten the procedure time and adhere to contamination precautions (Tay et al., 2020). Tracheostomy team need to include experienced surgeons with their assistants, intensivists, anesthesiologist and trained staff nurses. The number of persons involved in each procedure needs to be limited to four or five personnel. Before the procedure they need to organize a briefing and discuss about the steps so that everyone is aware of their respective roles by making sure that all the important steps and work flow will be conducted smoothly (Li et al., 2020).

Considering healthcare workers' safety during tracheostomy procedure, there is a need to use third level protection measure with addition of a powered air-purifying respirator (PAPR) (Chun-hui et al., 2020). However, centers without PAPR equipment, there is a need to apply second level protection measure which consists of N95 or FFP3 mask, face shield, goggles, head cover including neck protection, water impermeable overall gown, shoes' cover and use double gloves. To prevent repetitive connection and disconnection of the ventilation machine and minimize potential contamination to other patients during transportation, it is suggested that the tracheostomy procedure be performed at the bedside in ICU (Panuganti et al., 2020). Some centers that can prepare operation room with negative pressure airborne infection isolation room (AIIR) for COVID-19 cases only

with proper area for transportation preferred to do open tracheostomy in the operation theater with a suitable environment. If no AIIR is available, avoid being in the operation room for up to 3 hours due to persistence of viable virus in the aerosol (Doremalen et al., 2020).

From previous experience during SARS-COV-1, guidelines suggested the administration of systemic paralytic agent to paralyze the patient totally during the time of tracheal incision and endotracheal tube exchange to minimize or avoid coughing (Kwan et al., 2004). Coughing during the procedure can aerosolise droplets and might risk exposing healthcare workers to infection. During the procedure, surgeons are also advised to avoid using electro cautery and direct suctioning to prevent aerosolisation of viral particles (Panuganti et al., 2020; Wei et al., 2003). Direct communication between the surgeon and anesthetist teams is very important during open tracheostomy procedure. Ventilation needs to be held with ETT cuff deflated before the tracheal incision is made (David et al., 2020; JR & S, 2020). After tracheostomy tube has been inserted, the tube will be connected to the ventilator using viral filter (Zucco et al., 2020; Wax & Christian, 2020; Chen et al., 2020).

Post procedure, the most important step is the careful removal of PPE by following the Centers for Disease Control (CDC) prevention protocol to avoid contamination (CDC, 2020). CDC recommended that a personnel should be specifically designated to monitor and supervise this step (Tay et al., 2020).

Post-operative care

Precautionary steps for COVID-19 patient with tracheostomy need to be continued till post-operative care. Trained and experienced staffs are needed to manage the patient post-operatively (McGrath et al., 2020). Avoid any unnecessary airway interventions that can generate aerosol spread from patient. Level II protective measure is needed during handling the patient. Suctioning device need to be in a closed circuit system. If the patient is not connected to ventilation device, use of viral filter heat and moisture exchanger is needed. Authors suggested to delay first changing of tracheostomy in COVID-19 patient if not clinically indicated until the patient is considered non-infectious (Harrison et al., 2020). There are various recommendations for the time of first changing of tracheostomy that ranges from day 7 to day 30 post operation. Some centers may consider early tracheostomy changing in view of the risk of tracheal injury that can lead to tracheal stenosis by replacing the cuffed with an uncuffed one while other centers suggested for delayed changing due to the risk of infection to healthcare workers (Chiesa-Estomba et al., 2020). MOH Malaysia suggested in their latest guidelines to delay the first tracheostomy tube change at 8-10 days and donning a full PPE. They also suggested to prepare the “Tracheostomy Grab Bag” that comprise of tracheal dilator, headlight, sterile gloves, cuffed non-fenestrated tracheostomy tube of appropriate size and heat and moisture exchange filter (HMEF) nearby or at appropriate place that can be used during tracheostomy change or an emergency situation. The bag need to be checked and restocked regularly and made known by all members of the team (Ministry of Health, 2021).

Patient Outcomes Following Tracheostomy

Patient’s outcome is the most important parameter that need to be emphasized whether tracheostomy procedure is beneficial or not during COVID-19 pandemic. The mortality rate for patients with tracheostomy varies depending on the center. In August 2020, Tornari et al. reported having 5.1%

mortality rate from a total of 78 tracheostomies, of which 73 were percutaneous, 3 were hybrid procedures and 2 were open; with a median time of death about 16 days after intubation. About 5.1% (four) patients died before weaning of sedation due to COVID-19 disease. From survival group, 48.6% of decannulated patients were decannulated in the ICU and 51.4% were decannulated following step-down to level 2 care. There was no instance of failed decannulation for respiratory reasons. About 23.2% of the patients were discharged from hospital. The median duration was 23.5 days (ranging from 18.75–29.50 days) after tracheostomy (Tornari et al., 2020). However, Zuazua-Gonzalez, reported high mortality rate in their center with 56.7% deaths among the 30 tracheostomised patients. They also noted that patients who had tracheostomy showed slow progress with prolonged ICU stay or hospitalization compared to those patients who did not have tracheostomy. The COVID-19 airway team at Queen Elizabeth Hospital at Birmingham reported high survival rate of about 85% with no difference between early (day 10 and less) and late tracheostomy (more than 10 days). They also suggested that tracheostomy performed on day 14 was associated with shorter period of ventilation and ICU stay (Breik et al., 2020). Yeung et al.(2020) and Glibbery et al. (2020) reported that 19% to 61.1% tracheostomised patients were weaned off from ventilation with mean time 10-22 days. COVID Trach Collaborative group reported about 52% of their patients were alive and weaned off from ventilation at median of 8 days and 38% were discharged from intensive care. They had 12% mortality rate among COVID-19 patients with median of 8 days (and range of 1- 21 days) (Hamilton, 2020). Chao et al (2020) reported 11.3% mortality among 53 patients who underwent tracheostomy. About 56.6% of patients were weaned off from ventilation, with average time of tracheostomy to wean off ventilation was about 11.8 (SD= 6.9; range 2-32) days. About 13.2% of the patients were successfully decannulated and 30.2% were discharged alive (Chao et al., 2020). From the above reports, we noted that some of the patients benefited from the tracheostomy and there was improvement in ICU capacities.

Infected Healthcare Workers (Or Risk of infection among healthcare workers)

In Wuhan and Italy, the reported rate of healthcare workers infected by SARS-COV-2 was 3.8% and 15% respectively (Wu & McGoogan, 2020; Doremalen et al., 2020). However, a recent study showed that with proper protective measure using PPE minimum level II and following important steps in the procedure, the risk of infection was lower. Queen Elizabeth Hospital Birmingham COVID-19 airway team reported that they performed about 100 tracheostomies on ICU COVID-19 cases and none of the surgeons or staff were infected after two weeks post procedure (Breik et al., 2020). Bassily-Marcus et al. (2020) also reported that none of their staff experienced COVID-19 symptoms and all tested negative for antibodies. COVID Trach Collaborative, reported that none of their staff involved in performing the tracheostomy tested positive for COVID-19 within two weeks of the procedure. Performing early tracheostomy with median time of 11 days in 111 of COVID-19 patients did not cause any viral transmission to the tracheostomy team as evident by lack of symptoms and negative antibody testing (Hamilton, 2020). All of the authors reported that their teams were compliant and followed the steps to mitigate risk of exposure to SARS-CoV-2 aerosol and infection.

4. Conclusion

Viral load, risk of infection to healthcare workers, patient's disease progression, resources and facilities are among the factors that need to be addressed to decide the appropriate time to perform tracheostomy. Lower oxygen requirement ($FiO_2 < 0.4$, $PEEP < 10$), low Sepsis Related Organ Failure (SOFA) scores, ventilation for at least 10 days and signs of improvement are criteria for patient

selection. The operation techniques depend on the surgeon’s preference and available resources and facilities. There are many guidelines published as a reference to guide the clinician regarding tracheostomy procedure involving COVID-19 patients. However, the decision still depends on the multidisciplinary factors and are done on a case-by-case basis.

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