A Systematic Review on Guidelines and Recommendations for Tracheostomy during Covid-19 Pandemic

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Abstract

Aim: Global health care is experiencing an unprecedented surge in the number of critically ill patients who require mechanical ventilation due to the COVID-19 pandemic. The requirement for relatively long periods of ventilation in those who survive means that many are considered for tracheostomy to free patients from ventilatory support and maximise scarce resources. COVID-19 provides unique challenges for tracheostomy care: health-care workers need to safely undertake tracheostomy procedures and manage patients afterwards, minimising risks of nosocomial transmission and compromises in the quality of care. Conflicting recommendations exist about the timing and performance of tracheostomy and the subsequent management of patients. This is due to a number of factors including prognosis, optimal healthcare resource utilisation, and safety of healthcare workers when performing such a high-risk aerosol-generating procedure.

Methods: MEDLINE (accessed from PubMed) from 6 august 2019 to 7 august 2020 were systematically searched using: "COVID 19" OR "CORONAVIRUS" OR "SARS COV-2" AND "TRACHEOSTOMY" with filters as '2020' year of study, English language, full article available on 7/08/2020 at 11.30 Am.

Results: Total of 56 articles were obtained on search and the final 15 articles extracted based on our selection criteria were reviewed. A synthesis of the current international literature and reported experience is presented with respect to timing of tracheostomy, ideal place for tracheostomy, staff safety, procedure modification and post tracheostomy care thus leading to a pragmatic recommendation that tracheostomy is not performed until at least 14 days after endotracheal intubation in COVID-19 patients and if indicated should be done in negative pressure isolated ICU room with full PPE protection with some modification during procedure.

Conclusion: In selected COVID-19 patients, there is a role for tracheostomy to aid in weaning and optimise healthcare resource utilisation. Tracheostomy can be performed safely with careful modifications to technique and appropriate enhanced personal protective equipment.

Introduction

The coronavirus disease (covid19) pandemic (caused by the SARS-CoV-2 virus) is the greatest healthcare challenge in a generation. Clinicians are modifying the way they approach day-to-day procedures. Safety and reduction of transmission risk is paramount. Surgical tracheostomies in COVID 19 patients are aerosol generating procedures linked with a significant risk of viral contamination. The recent outbreak of SARS-CoV-2 has reached worldwide proportions since it began in late 2019 [1]. Due to the high virulence via aerosol transmissions, to date COVID-19 has infected more than 30.6 million COVID-19 cases and 950 000 deaths[weekly report WHO on 20 September [2]. Tracheostomy is a common procedure in critically ill patients who require an extended period of time on mechanical ventilation. Use of tracheostomy can facilitate weaning from ventilation and potentially increase the availability of intensive care unit (ICU) beds. When the COVID-19 pandemic spread to Italy and Spain, ICUs had a massive influx of patients who were critically ill, many of whom became candidates for tracheostomy. However, tracheostomy is an aerosol generating procedure, so health-care workers are at risk of infection during insertion and subsequent care, even when appropriate personal protective equipment (PPE) is used. COVID-19 provides unique challenges for tracheostomy care: health-care workers need to safely undertake tracheostomy procedures and manage patients afterwards, minimising risks of nosocomial transmission and compromises in the quality of care. Conflicting recommendations exist about the timing, ideal place, performance of tracheostomy and the subsequent management of patients.

Methodology

The report of this systematic review was made according to the recommendations of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (Fig. 1). The review protocol was not previously registered. MEDLINE (accessed from PubMed) from 6 august 2019 to 7 august 2020 were systematically searched for related published articles. In electronic databases, the following search strategy was implemented and these key words (in the title/abstract) were used: "COVID 19" OR "CORONAVIRUS" OR "SARS COV-2" AND "TRACHEOSTOMY". Articles written in English and available full text were all included in this search. All authors participated through each phase of the review independently (screening, eligibility, and inclusion). They independently screened the titles and abstracts yielded by the search against the inclusion criteria. They resolved any disagreement through discussions. Neither of the authors were blind to the journal titles or to the study authors or institutions. The following data were extracted from the included studies: study authors, study designs, main results. The methodological quality of the included studies was assessed by the authors. Aim of this systemic review is to provide a contemporaneous review of emerging data on COVID-19 with direct relevance to the planning, conduct, and subsequent management of tracheostomy during the pandemic. We included only human studies and articles with clearly defined clinical outcome. The exclusion criteria included animal studies and review articles. The search was performed at specified date and time on 7/08/2020 at 11.30 Am.

Results

Total of 56 full article studies were obtained on PubMed database search, out of which 41 studies were excluded after checking the relevance of title, not relevant content, review articles, head neck oncology related tracheostomy. Search was done strictly adhering to the PRISMA guidelines, as depicted in figure 1. We reviewed the final 15 articles based on our selection criteria to extract the following information from each: first author, date of publication. study design, main results data related to tracheostomy guidelines. The extracted data is jotted in Table 1.

SERIAL NUMBER. DOP	AUTHOR AND TYPE OF ARTICLE	TIMING OF TRACHEOSTOMY AND PLACE	PREPARATION	OPERATIVE STEPS	post tracheostomy care
1. 12-05-2020	Menegozzo et al ³ Technical note.	<ul style="list-style-type: none"> · after 14 days of intubation. · isolated room with lower pressure than the corridor. · If unavailable, use a room with closed doors and no laminar flow or operating room. 	<ul style="list-style-type: none"> · wear a hat, foot protection, PFF3 or N95 mask and a face shield OR goggles. · Apron and gloves (sterilized). · additional surgical mask (in front of the N95 or PFF3) can be used. 	<ul style="list-style-type: none"> · avoid electrocautery - risk of smoke formation. · adequate paralysis. · Stop ventilation, advance the occluded orotracheal tube and inflate the cuff below the site proposed for the tracheostomy. · Restore ventilation, confirm adequate pre-oxygenation and then stop ventilation again, ensuring time for complete expiration, and occlude the tube. · Create the tracheal window, minding the cuff, deflate ET and pull the tube until the tip is proximal to the tracheal window. · After insertion of the cannula, immediately inflate the cannula cuff with the syringe already attached to the cuff channel. · Remove the introducer and attach connection with the antiviral filter to the cannula and the circuit. · Restore ventilation and confirm positioning with 	<ul style="list-style-type: none"> · use a shower for body cleaning after tracheostomy. · Avoid humidified oxygen, use only filters. · suctioning always in a closed circuit. · Cuff always inflated. · Avoid dressing changes unless there are clear signs of infection. · Avoid switching the cannula before 7 to 10 days, giving preference to a period of lower viral load. · Use full PPE for exchanges. · Deflate the cuff only with the flow off and inflate the cuff of the new cannula immediately after insertion. · Use of cannulas without fenestrations until the COVID exam is negative.

				capnography (avoid using the stethoscope).	
2. 04-Apr-20	Jacob et al ⁴ letter TO EDITOR	<ul style="list-style-type: none"> · Negative pressure theatre or isolated room · If not available consider a normal theatre with closed doors during the procedure. · Consider turning off laminar flow [if present]. 	<ul style="list-style-type: none"> · surgeons must wear full PPE. · Consider additional protection – powered air purifying respirator-PAPR. 	<ul style="list-style-type: none"> · confirm paralysis. · Pre oxygenation with PEEP then stop ventilation and turn off flows. · Allow time for passive expiration with open APL valve. · consider clamping of ET then deflate cuff and advance beyond proposed tracheal window under direct vision. ensure window is sufficient size to allow easy insertion of tracheostomy tube without injury to cuff. · insert cuffed, non-fenestrated tracheal tube. · immediately inflate cuff and replace introducer with non-fenestrated inner tube and HME. · establish oxygenation with PEEP again. · confirm position with end tidal CO2 only to avoid contamination of stethoscope by auscultation. 	<ul style="list-style-type: none"> · humidified oxygen to be avoided, only HME. · use only in line closed suction circuit all times. · Periodic check cuff pressure. · cuff should not deflated. · do not change dressings unless frank sign of infection. · delay first tube change at least 7-10 days. · follow same sequence of pause in ventilation with flows off before deflating cuff and inserting new tube with immediately re-inflation of cuff and reconnection of circuit. · cuffed non fenestrated tube to be used until patient is covid-negative. · subsequent planned tube change at least 30 days interval.
3.	Souza Lima et al ⁵ technical note		<ul style="list-style-type: none"> · Reduce team members to just the essential required professionals. 	<ul style="list-style-type: none"> · initial advance of the endotracheal tube before the TCT window is performed to 	<ul style="list-style-type: none"> · Avoid changing the tracheostome until the patient has a COVID-19 negative.

			<ul style="list-style-type: none"> · Use the FFP3 / N95 mask, integrated visor/ full face shield / disposable sterile gowns resistant to liquids / fluids (waterproof). · Consider using "two gloves". · Use a conventional tracheostome, avoiding the fenestrated models. 	<p>reduce aerosol elimination;</p> <ul style="list-style-type: none"> • If possible, stop ventilation while the tracheal incision is being performed, and check that the cuff is already inflated before restarting ventilation; • Ventilation should be stopped before the insertion of the tracheostome, and perform a fast and accurate placement of the tracheostome with immediate inflation of the cuff; • Confirm the adequate placement, preferentially, with capnography, if available. • An HME type filter (Heat and moisture exchanger) must be placed on the tracheostome to reduce the exposure of the virus, in case of disconnection. 	<ul style="list-style-type: none"> · Only closed-circuit suction should be used.
4. 25-Apr-20	Bottia et al ⁶ case report	<ul style="list-style-type: none"> · ICU room with negative pressure. 	<ul style="list-style-type: none"> · sterile gown, cap, shoe covers, double gloves, N95 mask, goggles and face mask. 	<ul style="list-style-type: none"> · Paralyse the patient. · Establish adequate preoxygenation, · Avoid electrocautery. · Stop mechanical ventilation before tracheotomy. · Deflate the cuff of the endotracheal tube. · Push the tube forward 3 cm. 	<ul style="list-style-type: none"> · Careful removal of personal protective equipment with supervision. · Take a shower after procedure.

				<ul style="list-style-type: none"> · Perform tracheotomy with cold knife. · No tracheal or wound suctioning of blood or secretions should be attempted if not needed, to avoid aerosol generation. · Pull the endotracheal tube just above the tracheal incision under direct vision. · Insert the tracheal cannula, correctly inflate. · Give ventilation again. 	
5. 06-04-2020	Pichi et al ⁷ editorial	<ul style="list-style-type: none"> · provisional operating room set up in the ICU . · If not available, aerial-isolated room (i.e. doors and windows closed). 	<ul style="list-style-type: none"> · Cap and shoe covers. · Mask: FFP3 (Europe) or N99 (US) mask. · Goggles or face shield. · use of double gown is preferable. · use of double nitrile gloves is suggested. 	<ul style="list-style-type: none"> · no more than two expert surgeons per procedure should be involved. a single anesthetist would be suffice for mechanical ventilation and tube removal after tracheal incision. · non-fenestrated cuffed tracheostomy tube should be used. · deep neuromuscular blockade in order to avoid swallowing and cough reflexes. · Once the anterior wall of the trachea is exposed, the anesthetist: <ul style="list-style-type: none"> – reduces the oxygen-percentage of the inflated air to 21%; – pushes the tube as caudally as 	<ul style="list-style-type: none"> · No dressing change should be performed unless evidence of local infection and cannula cuff should be checked regularly and not be deflated unsafely. · The cannula should be held during any passive movement of the patient to avoid air leakage from the stoma. · Cannula change can be planned 7–10 days later using the same standards (PPE utilization and airflow interruption). cannula change

			<p>possible, so as to avoid cuff breach, – hyper-inflates the tube cuff to ensure lower airway isolation.</p> <p>· ventilation is stopped entirely, the tracheal tube is lifted, without extubating the patient, until its bottom side passes the tracheal window, then cannula is inserted in the tracheal lumen.</p> <p>· Promptly, the cannula cuff is inflated at the appropriate pressure level and heat and moisture exchanger is positioned: only then the ventilation is resumed by close airway circuit attachment.</p> <p>· Tracheal cannula should be considered correctly positioned until CO2 value is displayed, avoiding stethoscope contamination by thoracic auscultation.</p>	can be delayed 30 days after.
6. 04-Apr-20	Kligerman et al ⁸ special issue	· PPE- N95 mask, face shield, gown, and gloves.	<p>· Closed circuit ventilation.</p> <p>· Cuffed tracheostomy tubes should be used to decrease leaks in the circuit.</p> <p>· Use of in-line suction, even for patients who may not require chronic closed-circuit ventilation may also decrease risk</p>	<p>· Patients not on a closed ventilation circuit should wear a surgical mask over their stoma if tolerated as this may decrease spread of droplets from leakage around the stoma and/or HME.</p> <p>· tube change should be postponed</p>

			<p>of aerosolization and droplets.</p> <ul style="list-style-type: none"> · Nebulizer treatments should be avoided or used with caution as well to minimize risk of aerosolization. 	<p>and manipulation of the tracheostomy site should be minimized.</p> <ul style="list-style-type: none"> · all nonurgent clinic visits should be postponed and/or converted to telehealth visits when possible.
7. 31-Mar-20	<p>Kowalski et al⁹</p> <p>SPECIAL ISSUE</p>	<ul style="list-style-type: none"> · wearing PPE such as N95 or FFP2 mask or PAPR, gown, cap, eye protection, and gloves to decreasing the risk of aerosolization. 	<ul style="list-style-type: none"> · stop ventilation while the tracheostomy window is being performed, and only resume ventilation when the cuff of the tracheostomy tube has been inflated. 	
8. 31-Mar-20	<p>Vargas et al¹⁰</p> <p>SPECIAL ISSUE</p>	<ul style="list-style-type: none"> · full protective wearing including N95 respirator, gown, cap, eye protection, and gloves. 	<ul style="list-style-type: none"> · To avoid the aerosol, push down the endotracheal tube beyond the site chosen for the tracheal stoma at the beginning of the procedure. · The endotracheal tube should reach the tracheal carina so the cuff is surely distal to the tracheostomy site. 	
9. 08-Apr-20	<p>Xiao et al¹¹</p> <p>LETTER TO THE EDITOR</p>		<ul style="list-style-type: none"> · procedures should be performed under general anesthesia, with deprivation of spontaneous respiration and application of muscle relaxants regardless of whether patients had spontaneous breathing or not, to restrain the cough reflex caused by tracheal stimulation. 	

- after the cervical trachea is exposed and immediately before an incision is made in the trachea, the endotracheal tube (ETT) is inserted deeper, positioned with the tip close to carina of the trachea .

- This step would prevent the ETT cuff leak due to an accidental damage to the cuff when making the tracheal opening.

- when the opening is complete, brief interruption of the ventilator is essential. Then the ETT is pulled out, and subsequently the tracheostomy tube quickly inserted into the opening almost simultaneously, the tracheostomy tube cuff is inflated and the tube rapidly connected to the ventilator with immediate resumption of the ventilator .

- Suspension of ventilation support was usually not more than 15 seconds, with satisfactory oxygen saturation.

10. 08-Apr-20	Miles DDS et al ¹² SPECIAL ISSUE	<ul style="list-style-type: none"> · 21 days after the onset of symptoms if feasible. · Tracheostomy should not be 	<ul style="list-style-type: none"> · waterproof cap, goggles with an antimist screen, impermeable operating room surgeon's gown and gloves and a transparent 	<ul style="list-style-type: none"> · paralysis to prevent coughing. · glycopyrrolate to reduce secretions. 	<ul style="list-style-type: none"> · Securing circuits properly and avoiding unnecessary humidification systems may reduce the risk of unexpected
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		<p>delayed regardless of SARS-CoV-2 status in life-saving situations or in situations in which the tracheostomy would significantly improve the prognosis of the patient.</p> <ul style="list-style-type: none"> · Ideally, the procedure should be performed at bedside in the intensive care unit in a negative pressure room or using a portable high efficiency particulate air (HEPA) filtration system to avoid patient transportation and contamination of other areas in the medical center. · If it is necessary to perform the procedure in the operating room (OR), a specific OR cluster should be designated to avoid contamination of additional OR resources for noninfected patients. 	<p>plastic facial shield worn outside the goggles and N95.</p> <ul style="list-style-type: none"> · The minimum number of health care workers required to perform the procedure should be present to prevent unnecessary exposures. · Consideration for power air-purifying respirator (PAPR) systems for personnel performing tracheostomy should be entertained. 	<ul style="list-style-type: none"> · preoxygenation and cessation of ventilation during the tracheostomy procedure. · utilization of closed suctioning systems. · avoiding monopolar electrocautery, or harmonic technology, and using cold instrumentation when feasible. · minimizing suctioning during the procedure. ensuring the · cuff is inflated prior to resuming ventilation, the circuit should be close type. 	<p>circuit disconnection and aerosolization leading to exposure.</p> <ul style="list-style-type: none"> · The circuit should remain closed as much as possible, and closed-line suctioning should be used. · Heat moisture exchangers with viral filters and HEPA filtration should be used when possible. · Tracheostomy tube changes should be avoided and should only be performed in cases of cuff failure or emergent situations.
11. 09-Apr-20	David et al ¹³ SPECIAL ISSUE	<ul style="list-style-type: none"> · 21 day postintubation. · Ventilator parameters to qualify for safe tracheostomy placement include positive endexpiratory pressure (PEEP) < 12 and fraction of inspired 	<ul style="list-style-type: none"> · N95 mask or PAPR, head covering, eye protection, gown, and two pairs of gloves. 	<ul style="list-style-type: none"> · Limit number of providers in the room during the procedure. · Use of paralysis to prevent coughing. · holding ventilation when the ETT cuff is deflated and 	<ul style="list-style-type: none"> · Use of closed, inline suctioning. · Closed circuit with HEPA filter if on mechanical ventilatory support. · HME when off

		<p>oxygen (FiO₂) < 0.60.</p> <ul style="list-style-type: none"> ICU preferred or negative pressure room. 		<p>when the trachea is opened.</p> <ul style="list-style-type: none"> Avoid use of laryngotracheal topical anesthesia. Holding ventilation during tracheotomy until cuff inflated and circuit reconnected. 	<p>ventilatory support.</p> <ul style="list-style-type: none"> Delaying the first tracheostomy change to 1 month or after deisolation occurs for COVID-19 positive patients.
12. 14-Apr-20	<p>Skoog et al¹⁴</p> <p>SPECIAL ISSUE</p>	<ul style="list-style-type: none"> >30 days from diagnosis. negative pressure room. Procedures should be completed in the ICU at bedside to avoid risk of exposure during transport. 	<ul style="list-style-type: none"> minimal PPE worn by staff should include N95, mask with shield, surgical gown, double gloves. PAPR. HEPA filter "air scrubber" should be placed in the room. 	<ul style="list-style-type: none"> Patients were completely paralyzed to minimize air movement and coughing and thus viral dissemination via aerosolization. Just prior to airway entry, the patients were pre-oxygenated, ventilation was held, and the cuff on the endotracheal tube was dropped to minimize air movement over the respiratory mucosa. While the patient was apneic, the tracheotomy incision was performed. Open suctioning of the trachea was avoided. Instead, a closed suctioning system with a viral filter was used. ventilation only with cuff inflation. avoiding suctioning once the trachea is incised due to the risk of 	<ul style="list-style-type: none"> closed suction system with viral filter. Keep cuff inflated. Delay first tracheotomy tube change to 3-4 weeks, if possible avoid changing tracheotomy tube until after COVID has passed.

				<p>aerosolization of high viral load secretions.</p> <ul style="list-style-type: none"> · minimizing cautery due to concerns of aerosolization of viral particles in the smoke plume. 	
13. 16-Apr-20	Broderick et al ¹⁵	<ul style="list-style-type: none"> · dedicated "Covid Theatre", operates under negative pressure. Reverse laminar flow in the perimeter around the operating table is estimated to exchange 90% of air (removing the generated aerosol) in 6 minutes. 	<ul style="list-style-type: none"> · PPE- FFP3 face mask, surgical hood, goggles or visor and double gloves. · consider deep suctioning of the chest and oral cavity using the closed suctioning circuit prior to transfer to minimises the amount of secretions at the time of opening the trachea. · Security staff has to close the corridor temporarily during transfers, and the anaesthetic team needs to put on PPE prior to entering ICU . · The patient is transferred along the back corridor of the theatres and not through the main theatre entrance. · viral filter should remain on the endotracheal tube. 	<ul style="list-style-type: none"> · The patient should be fully paralysed. · suction the ET tube again, including subglottic port . · confirm adequate muscle relaxation. · keep a closed circuit until the tracheostomy tube is inserted in the trachea. · Prior to tracheal window, stop the ventilator and deflate the balloon/cuff. Afterwards, the surgeon makes the window in the trachea. Minimal suctioning is used. · Once the window is achieved the ET tube is advanced further (past the window) and the balloon/cuff is re-inflated (over-inflated),thus establishing a closed circuit. · At this stage the patient is ventilated and the tracheal window lies above the level of the ET cuff allowing ample time for the surgeon to 	A closed suctioning is used.

			<p>check haemostasis and insert a rescue-suture.</p> <ul style="list-style-type: none"> · The ventilator is then stopped again, the cuff is deflated and the ET tube is withdrawn slowly to allow the insertion of the tracheostomy and inner tube. · The tracheostomy cuff is inflated and the circuit is connected. The capnography CO2 trace is confirmed. The ET tube is simultaneously clamped while the tracheostomy is being placed.
Schultza et al ¹⁶ consensus	<ul style="list-style-type: none"> · limitation of the number of caregivers present in the operating room. · full face shield/visor or airtight protective glasses. • FFP2 (N95) or FFP3 mask; • headlight covered by a head cap; • an impermeable protective apron or an overcoat that must be worn under the surgical gown as it is not sterile. an apron or a gown, head protection with a hood cap rather than with a simple cap in order to better prevent any skin exposure, 	<ul style="list-style-type: none"> · minimize the use of electrocoagulation which can generate aerosolization of the virus when the trachea is open; • when possible, use a sterile transparent interface between the patient and the surgeon, in order to limit the risk of contamination; • if possible: carry out a drug assisted neuromuscular block to reduce any risk of coughing when opening the trachea; • stop ventilation just before the trachea is incised; Tracheostomy under local anesthesia is not recommended. However, if it is 	<ul style="list-style-type: none"> · surgical hand scrub and/or friction with hydro-alcoholic solution before and after each treatment. · For tracheostomy change, abundant spraying of 5% lidocaine into the tracheostomy tube, followed by an aspiration a few minutes later, is useful. · If the patient is ventilated on the tracheostomy cannula, the anesthesiologist is asked to sedate the patient and perform a neuromuscular

necessary, it is recommended to inject 5 cc of Lidocaine 5% intratracheally through the tracheal wall, before the incision of the trachea is performed in order to reduce the cough reflex.

block to reduce any risk of coughing during the change of the cannula. All disposable material that has been in contact with the cannula or trachea (filters, suction probes) during the post-tracheostomy care must be eliminated through the infectious waste circuit. It is possible to use a room without air treatment provided that. the bedroom door is kept closed; the patient's room is regularly ventilated; the air pressure in the room is maintained at zero. the cannula should ideally be connected to an HME filter and covered by a surgical mask.

14. April 6, 2020	Foster et al ¹⁷ novel approach	· negative pressure operating room.	· PPE-boot covers, sterile gown, gloves, surgical mask, powered air-purifying respirators(PAPRs). · The Ecolab Scope Pillow Warmer Drape is a clear plastic material that is stretched over the retractor arms, forming a barrier between the operative field and the surgeon, while still allowing for good visualization of the operative field.
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The drape is then secured with snaps to the self retaining retractor to maintain the tightness of the drape; this will improve visibility. Buffalo Filter smoke evacuator tubing is connected to 2 heat moisture exchange (HME) filters and placed under the drape to provide further air filtration. The operator and assistant will proceed with hands underneath the drape.

15. Jul 2, 2020	Youn et al ¹⁸ case report	<ul style="list-style-type: none"> · at bedside in a negatively pressured ICU room to minimize the risks of transmission during transfer and worsening of the patient's condition. 	<ul style="list-style-type: none"> · (PPE) consisting of a Level C powered air-purifying respirator (PAPR) with an aseptic waterproof surgical gown and gloves. 	<ul style="list-style-type: none"> · Avoid bipolar electrocoagulator to prevent droplet aerosolization. · injection of sedatives and neuromuscular blockers needed. · Prior to opening of the second tracheal ring, the FiO2 was lowered to 0.4 and the balloon was temporarily overinflated. · The balloon was below the level of the tracheal opening. · No droplets escaped the opening due to the repositioned and overinflated balloon. The ET tube was withdrawn until the tip of the tube reached above the tracheal opening. · During withdrawal, to prevent the spread of droplets,
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pausing the ventilator was considered before balloon deflation. Immediately after ET tube tip repositioning, a hole was made on a transparent film dressing with scissors and a tracheostomy tube was immediately inserted.

· After a quick check of tracheostomy tube patency with a rubber catheter, the ventilator was connected, the tidal volume was checked, and the existing ET tube was removed.

Discussion

General Recommendations for Tracheostomy in COVID-19 Patients based on systemic analysis of included articles is developed as under:

TIMING OF TRACHEOSTOMY: There is no evidence as to the optimal timing of tracheostomy, when considering the current literature with respect to the disease process, the best use of healthcare resources, and staff safety waiting for 14 - 30 days will be beneficial. The evidence thus far in terms of viral load risk would suggest that delaying tracheostomy to at least 14 days postintubation would represent the safest possible balance. Given the natural disease course, this would likely represent at least 3 weeks since the onset of symptoms. Timing of procedure preferably applied between ventilator days 14–21 when viral load is expected to be decreasing and 21-30 days after onset of symptoms.

PLACE OF PROCEDURE: The ideal location for performing a tracheostomy on a COVID-19 positive patient is isolated room with lower pressure than the corridor. If unavailable, use a room with closed doors-windows and no laminar flow or Operating room or ICU room with negative pressure or using a portable high efficiency particulate air (HEPA) filtration system at bedside ICU setup .This setting would be ideal but not always feasible due to their limited availability and resource implications in a pandemic.

PREPARATION AND SAFETY: Personal protective equipment - PPE should include: Fitted respiratory mask [N95 OR PAAR OR PFF3], surgical cap, impermeable sterile gown, shoe covers, goggles, and full-face shields, sterile double gloves and additional surgical mask (in front of the N95 or PFF3) can be used. Minimize number of people in the room to 3 (2 procedural staff-ENT surgeon and anaesthetic). Use a conventional tracheostomy tube avoiding the fenestrated models. HEPA filter "air scrubber" should be placed in the room. Consider deep suctioning of the chest and oral cavity using the closed suctioning circuit prior to transfer to minimises the amount of secretions at the time of opening the trachea. Security staff has to close the corridor temporarily during transfers and the anaesthetic team needs to put on PPE prior to entering ICU. The patient is transferred along the back corridor of the theatres and not through the main theatre entrance. viral filter should remain on the endotracheal tube.

OPERATIVE STEPS/TECHNIQUE MODIFICATION:

- Avoid electrocautery - risk of smoke formation and viral transmission via aerosol.
- Pre oxygenation with PEEP then stop ventilation and turn off flows.
- Allow time for passive expiration with open APL valve.
- To avoid the aerosol consider clamping of ET then deflate cuff and push down the endotracheal tube beyond the site chosen for the tracheal stoma at the beginning of the procedure.
- The endotracheal tube should reach the tracheal carina so the cuff is surely distal to the tracheostomy site. This step would prevent the ET cuff leak due to an accidental damage to the cuff when making the tracheal opening.
- Create the tracheal window, minding the cuff, deflate it and pull the tube until the tip is proximal to the tracheal window.
- when the opening is complete, brief interruption of the ventilator is essential. Then the ET is pulled out, and subsequently the tracheostomy tube quickly inserted into the opening almost simultaneously, the tracheostomy tube cuff is inflated and the tube rapidly connected to the ventilator with immediate resumption of the ventilator.
- At this stage the patient is ventilated and the tracheal window lies above the level of the ET cuff allowing ample time for the surgeon to check haemostasis and insert a rescue-suture.
- Suspension of ventilation support was usually not more than 15 seconds, with satisfactory oxygen saturation.
- No tracheal or wound suctioning of blood or secretions should be attempted if not needed, to avoid aerosol generation.
- insert cuffed, non-fenestrated tracheal tube only.
- confirm position with end tidal CO2 only to avoid contamination of stethoscope by auscultation.
- An HME type filter (Heat and moisture exchanger) must be placed on the tracheostomy tube to reduce the exposure of the virus, in case of disconnection of circuit.
- Nebulizer treatments should be avoided or used with caution as well to minimize risk of aerosolization. keep a closed circuit until the tracheostomy tube is inserted in the trachea.

POST-PROCEDURAL CARE AND REHABILITATION:

- Team involved in the procedure use a shower for body cleaning.
- Avoid humidified oxygen, use only HME filters.
- suctioning always in a closed circuit.
- cuff always inflated.
- Avoid dressing changes unless there are clear signs of infection.
- Avoid switching the cannula before 7 to 10 days, giving preference to a period of lower viral load.
- Follow same sequence of pause in ventilation with flows off before deflating cuff and inserting new tube with immediately re-inflation of cuff and reconnection of circuit.
- Use full PPE for exchanges.
- Deflate the cuff only with the flow off and inflate the cuff of the new cannula immediately after insertion.
- Next Subsequent planned tube change at least 30 days interval.
- Avoid changing the tracheostomy tube until the patient has a COVID-19 negative report.
- The cannula should be held during any passive movement of the patient to avoid air leakage from the stoma.
- Patients not on a closed ventilation circuit should wear a surgical mask over their stoma if tolerated as this may decrease spread of droplets from leakage around the stoma and/or HME.
- Manipulation of the tracheostomy site should be minimized.
- all nonurgent clinic visits should be postponed and/or converted to telehealth visits when possible.
- Use Closed circuit with HEPA filter if on mechanical ventilatory support.
- Use HME when off ventilatory support.
- If the patient is ventilated on the tracheostomy cannula, the anesthesiologist can be asked to sedate the patient and perform a neuromuscular block to reduce any risk of coughing during the change of the cannula.
- All disposable material that has been in contact with the cannula or trachea (filters, suction probes) during the post-tracheostomy care must be eliminated through the infectious waste circuit.
- It is possible to use a room provided that,
the patient's room door is kept closed; the patient's room is regularly ventilated; the air pressure in the room is maintained at near zero,
the cannula should ideally be connected to an HME filter and covered by a surgical mask.
- Use of cannulas without fenestrations until the COVID exam is negative.

The focus of early post-procedural care is to ensure minimisation of aerosol generation risk to healthcare workers and other patients until any risk has passed. Early measures include keeping the cuff inflated, use of in-line suction, and avoidance of humidified oxygen if possible. Cuff deflation, changing of tracheostomy tube and progress on a decannulation protocol should be deferred until the patient is COVID19 negative where possible. We suggest reducing the frequency of changing an inner cannula (if used) and cuff pressure checks; these decisions should be made on an individual basis and reviewed daily .We recommend commencing care after tracheostomy with a simple heat and moisture exchange filter to provide humidification; the requirement for heated, water-based humidification or adjuncts, such as saline or hypertonic saline nebulisers, should be made on an individual basis and reviewed daily . We suggest that facemasks and tracheostomy shields be used by patients undergoing trials of tracheostomy cuff deflation to mitigate risks of aerosols

ANESTHETIC CONSIDERATIONS: Deep neuromuscular blockade should be instituted. Avoid circuit disconnection as much as possible.

Conclusion

Our recommendations on the use of tracheostomy during the COVID-19 pandemic are presented in above mentioned panel. A defining feature of this pandemic is its pervasive and variable character. Increases in the number of patients with COVID-19 who are critically ill can swiftly overwhelm hospitals, particularly because many require extended periods of ventilator support, and many will require tracheostomy to facilitate recovery. Because tracheostomy is at the intersection of health-care worker safety, resource allocation, and patient-centred care, sound guidance is crucial. Many questions remain unanswered, and prospective data are needed to answer pressing questions around tracheostomy in the setting of the COVID-19 pandemic. Data on infectivity and persistence of viral RNA in patients who are critically ill are sparse, particularly at timepoints beyond 20 days after symptom onset, when tracheostomy is typically considered. The predictive value of peak viral load and antibody response for gauging infectivity and transmission risks associated with different strategies for tracheostomy insertion require further study. Tracheostomies in COVID-19 patients present themselves as extremely high-risk procedures for all members of the procedural team. Systematic meticulous planning of each procedural step is warranted along with strict adherence to local/ institutional protocols to mitigate risk to procedural members. These proposals provide a robust framework on which to base delivery of tracheostomy services for critical care units during the COVID-19 pandemic, this can prove an invaluable resource. At present, there is no high-level evidence beyond case series upon which to make definitive recommendations, but we have based our proposed guidelines upon consensus from the currently available literature to form a pragmatic and safe approach. There is no doubt that as more rapidly emerging higher-level evidence becomes available, our recommendations will be refined and improved. The decision to perform tracheostomy in these patients requires careful consideration, planning and regular scrutiny if it is going to be of net benefit to patients and critical care services in terms of optimising healthcare resource utilisation, ensuring patient and staff safety and providing optimal long-term outcomes. Urgent planning, training and collaborative data collection will be vital, and ENT surgeons have the potential to offer a valuable role in supporting critical care teams with this service at a very challenging time.

Abbreviations

PAPR: powered air purifying respirators, PPE-Personal protective equipment, HME- Heat and Moisture exchanger, HEPA- high efficiency particulate air. PEEP – positive end expiratory pressure. APL-adjustable pressure limiting valve, ET- endotracheal tube.

Declarations

Conflict of Interest:

There is no conflict of interest among authors.

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Figures

Figure 1

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