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ORIGINAL ARTICLE

Retrospective Cohort Study

Clinical characteristics of COVID-19 patients who underwent tracheostomy and its effect on outcome: A retrospective observational study

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Abstract

BACKGROUND

The exponential rise in Coronavirus disease 2019 (COVID-19) cases has resulted in an increased number of patients requiring prolonged ventilatory support and subsequent tracheostomy. With the limited availability of literature regarding the outcomes of COVID-19 patients with tracheostomy, we attempted to study the clinical characteristics and multiple parameters affecting the outcomes in these patients.

AIM

To determine all-cause mortality following tracheostomy and its association with various risk factors in COVID-19 patients.

METHODS

This retrospective study included 73 adult COVID-19 patients admitted to the ICU between 1 April, 2020 and 30 September, 2021 who underwent tracheostomy as a result of acute respiratory failure due to COVID-19. The data collected included demographics (age, sex), comorbidities, type of oxygen support at admission, severity of COVID-19, complications, and other parameters such as admission to tracheostomy, intubation to tracheostomy, ICU stay, hospital stay,

and outcome.

RESULTS

This study included 73 adult patients with an average age of 52 ± 16.67 years, of which 52% were men. The average time for admission to tracheostomy was 18.12 ± 12.98 days while intubation to tracheostomy was 11.97 ± 9 days. The mortality rate was 71.2% and 28.8% of patients were discharged alive. The mean duration of ICU and hospital stay was 25 ± 11 days and 28.21 ± 11.60 days, respectively. Greater age, severe COVID-19, mechanical ventilation, shock and acute kidney injury were associated with poor prognosis; however, early tracheostomy in intubated patients resulted in better outcomes.

CONCLUSION

Patients with severe COVID-19 requiring mechanical ventilation have a poor prognosis but patients with early tracheostomy may benefit with no added risk. We recommend that the timing of tracheostomy be decided on a case-by-case basis and a well-designed randomised controlled trial should be performed to elucidate the potential benefit of early tracheostomy in such patients.

Key Words: COVID-19; Intubation; Mechanical ventilation; ICU; Tracheostomy; Oxygen therapy

Core Tip: Tracheostomies are commonly performed in critically ill patients who require mechanical ventilation for a prolonged duration. Various recommendations and guidelines have been published regarding the safety of tracheostomy in Coronavirus disease 2019 (COVID-19) patients but literature with respect to indication, timing and outcome of tracheostomy in COVID-19 patients is still lacking. Therefore, in this study we aimed to describe the clinical characteristics of patients who underwent elective tracheostomies and multiple parameters affecting the outcomes in these patients. We found that patients with severe COVID-19 requiring mechanical ventilation had a poor prognosis but patients with early tracheostomy may benefit from this procedure.

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INTRODUCTION

The Coronavirus disease 2019 (COVID-19) pandemic has resulted in extreme stress in healthcare establishments worldwide. Various studies have shown that 5%-15% of the patients with COVID-19 will develop severe disease requiring endotracheal intubation and mechanical ventilation[1,2]. Some patients may require prolonged ventilatory support. Tracheostomies are commonly performed in critically ill patients who require prolonged mechanical ventilation[3]. Compared with the orotracheal tube, the tracheostomy tube bypasses the mouth and pharynx resulting in better patient comfort and sedation requirement[4]. Other benefits of tracheostomy include a reduced incidence of ventilator-associated pneumonia, reduction in anatomical dead space leading to less work of breathing, easy airway suctioning and toileting, and facilitation of weaning from mechanical ventilation[5]. During the pandemic, tracheostomy will help in early transition of the patients from ICU care to ward care, thus helping to create a much-needed ICU bed that is always scarce in resource-limited countries with limited manpower. Tracheostomy will also help reduce the generation of highly infectious aerosols that are associated with the use of high flow oxygen devices or non-invasive ventilation[6].

Various guidelines have been published regarding the safety of tracheostomy in COVID-19 patients; however, literature regarding the indications, timing, and outcomes of tracheostomy in COVID-19 patients is lacking[7,8]. Some authors suggest that tracheostomy should be delayed for at least 14 days after endotracheal intubation to obtain better information regarding patient prognosis along with reduced viral load[9-13]. Early tracheostomy is advised so that patients can be weaned from the ventilator and transferred to ward care sparing the ICU bed[14]. However, these recommendations are based on expert opinions and a well-designed study is needed to provide a high level of evidence. In this study, we aimed to describe the clinical characteristics of patients who underwent elective tracheostomies and to study multiple parameters affecting the outcomes of these patients.

MATERIALS AND METHODS

Study overview

This study was conducted by the Department of Anaesthesiology, Pain Medicine, and Critical Care in a tertiary care centre. The retrospective data presented in this study is part of the project titled-Post discharge outcomes of COVID-19 patients following admission to the intensive care unit, which was approved by the institute ethics committee (IEC-291/17.04.2020). As the study is retrospective in nature, informed written consent from individual patients was waived. Major databases such as PubMed, Embase, Scopus, Web of Science and Google Scholar were searched to identify the latest literature. The search was strengthened using a new tool called Reference Citation Analysis (https://www.referencecitationanalysis.com/).

Inclusion criteria

The study included all confirmed COVID-19 adult patients admitted to the ICU who underwent tracheostomy between April 1, 2020 and September 30, 2021.

Exclusion criteria

All patients with missing data or polytrauma cases who were incidentally COVID-19 positive were excluded from the study.

Data collection

Data were retrospectively collected using medical records and a computerized patient record system. Data collected included demographics (age, sex), comorbidities, type of oxygen support at admission, the severity of COVID-19, complications, and tracheostomy-related parameters such as admission to tracheostomy, intubation to tracheostomy, ICU stay, hospital stay, and outcome. The timing of tracheostomy was classified as early (within 10 days of intubation) and late (more than 10 days of intubation).

Statistical analysis

The primary outcome of the study was to measure all-cause mortality following tracheostomy and its association with various risk factors. The secondary outcome included various tracheostomy-related parameters such as the timing of tracheostomy, admission to tracheostomy, intubation to tracheostomy, ICU stay, and hospital stay. Continuous variables were expressed as mean ± SD and categorical variables as number (percentage). Group comparison was performed using independent *t*-tests or Fisher's exact test. *P* values less than 0.05 were considered statistically significant.

RESULTS

During the study period, 113 mechanically ventilated patients with confirmed COVID-19 who underwent tracheostomy were screened for possible inclusion in the study. Seventy-three patients satisfied the inclusion criteria. They were further subdivided into survivors and non-survivors.

Table 1 shows the patient's demographics, comorbidities, COVID-19 severity, initial respiratory support, and tracheostomy-related parameters. The average age of the patients was 52 years (SD 16.67) and 52% were male. Hypertension was the most common comorbidity (35.6%) followed by chronic kidney disease with superimposed acute kidney injury (34.3%), diabetes (24.6%), cerebrovascular accident (15.1%), and coronary artery disease (5.44%). The most common oxygen therapy modality used at the time of ICU admission was mechanical ventilation (42.5%), followed by a non-rebreathing mask (19.2%), high flow nasal canula (10.9%), room air (12.3%), face mask (8.2%) and non-invasive ventilation (6.8%). Most of the patients who were admitted to the ICU were suffering from severe COVID-19 (50.6%) followed by moderate (30.2%) and mild (19.2%) disease. The mortality rate was 71.2% and 28.2% were discharged alive. The mean duration of ICU and hospital stay was 25 ± 11 days and 28.21 ± 11.60 days, respectively.

The average time for admission to tracheostomy was 18.12 ± 12.98 days while intubation to tracheostomy was 11.97 ± 9 days. In 35 (47.9%) patients, tracheostomies were performed early *i.e.*, within 10 days of intubation. Subgroup analysis among survivors and non-survivors showed that patients in the non-survivor group were older ($P = 0.02$), had severe COVID-19 ($P = 0.001$), and had a late tracheostomy ($P = 0.03$) as compared to survivors. However, the number of days from admission to tracheostomy, duration of ICU, and hospital stay were not significantly different between survivors and non-survivors (Table 2).

Table 1 Clinical-demographic parameters of COVID-19 patients who underwent tracheostomy

Characteristics	*n* = 73
Age (yr)	52 ± 16.67
Male	38 (52%)
Female	35 (48%)
Comorbities & COVID related complications *n* (%)	
HTN	26 (35.6%)
DM	18 (24.66%)
CAD	04 (5.44%)
CKD with AKI	25 (34.3%)
CVA	11 (15.1%)
TBI	02 (2.74%)
Stroke	05 (6.8%)
Pneumothorax	10 (13.7%)
Mucormycosis	06 (8.22%)
Shock	44 (60.2%)
COVID severity *n* (%)	
Mild	14 (19.2%)
Moderate	22 (30.2%)
Severe	37 (50.6%)
Initial respiratory support *n* (%)	
RA	9 (12.3%)
FM	6 (8.2%)
NRBM	14 (19.2%)
HFNC	8 (10.9%)
NIV	5 (6.8%)
MV	31 (42.5%)
Tracheostomy related events (mean ± SD)	
Admission to tracheostomy (d)	18.12 ± 12.98
Intubation to tracheostomy (d)	11.97 ± 9
ICU stay (d)	25 ± 11
Hospital stay (d)	28.21 ± 11.60
Death (*n*, %)	52 (71.2%)
Discharge (*n*, %)	21 (28.8%)

HTN: Hypertension; DM: Diabetes mellitus; CAD: Coronary artery disease; CKD with AKI: Chronic kidney disease with acute kidney injury; CVA: Cerebrovascular accident; TBI: Traumatic brain injury; RA: Room air; FM: Face mask; NRBM: Non-rebreathing mask; HFNC: High-flow nasal cannula; NIV: Non-invasive ventilation; MV: Mechanical ventilation.

DISCUSSION

This retrospective study describes the effect of tracheostomy in COVID-19 patients suffering from acute respiratory failure in a tertiary care centre in northern India. In our cohort of tracheotomized patients with COVID-19 pneumonia, we found that the average time from intubation to tracheostomy was 12 days; tracheostomy was performed in 6.4% of the patients admitted to the ICU. This rate is slightly lower than the French COVID-ICU study which reported a rate of 9%[15]. The patients in the non-survivor group were older and had severe COVID-19 and late tracheostomy.

Table 2 Comparison of tracheostomy-related events between survivors and non-survivors

Parameters		Survivors	Non-survivors	*P* value
Age (yr)		44.95 ± 4.19	54.84 ± 2.05	0.02
Gender male		12 (57.2%)	26 (50%)	0.38
Female		9 (42.8%)	26 (50%)	
Comorbidities	Present	06 (28.6%)	16 (30.77%)	0.54
	Absent	15 (71.4%)	36 (69.23%)	
COVID severity	Mild	10 (71.4%)	04 (28.6%)	0.001
	Moderate	03 (13.6%)	19 (86.4%)	
	Severe	08 (21.6%)	29 (78.4%)	
Admission to tracheostomy (d)		17.09 ± 2.54	18.53 ± 1.88	0.67
Intubation to tracheostomy (d)		9.19 ± 8.57	13.09 ± 9.02	0.01
Early tracheostomy (< 10 d)		14 (66.6%)	21 (40.3%)	
Late tracheostomy (> 10 d)		7 (33.4%)	31 (59.6%)	0.03
ICU stay (d)		26.19 ± 3.50	24.55 ± 1.41	0.6
Hospital stay (d)		30.85 ± 3.15	27.15 ± 1.41	0.21

The timing of tracheostomy in COVID-19 has been a matter of debate as published studies have presented heterogeneous results[8,16-19] and this debate is not going to be settled as most of the studies on tracheostomy are retrospective in nature. Various researchers have demonstrated that early tracheostomy has the advantage of rapid weaning from mechanical ventilation, decreased need for sedation, and shorter length of ICU stay[20]. Other proposed advantages include reduced risk of oropharyngeal and laryngeal damage as well as facilitation of oral feeding and oral care[21].

Before the COVID-19 pandemic, a systematic review by Adly *et al*[20] suggested that early tracheostomy *i.e.*, within 7 days, was associated with a reduced duration of mechanical ventilation, decreased mortality rate, and shorter length of ICU stay. A Cochrane review by Andriolo *et al*[22] found that early tracheostomy was associated with lower mortality rates and a higher probability of discharge from the ICU at day 28. However, a meta-analysis by Griffiths *et al*[23] and Siempos *et al*[24] demonstrated that there was no survival benefit following early tracheostomy as compared to late tracheostomy. The TracMan randomized controlled[25] trial comparing early (within 4 days) *vs* late tracheostomy (after 10 days), demonstrated that there were no differences in 30-day mortality and 1- and 2-year survival or length of ICU stay between them.

During the COVID-19 pandemic, various studies have described different timing of tracheostomy. Kwak *et al*[26], the Queen Elizabeth Hospital Birmingham COVID-19 airway team[27], Angel *et al*[28], Chao *et al*[10], Martin-Villares *et al*[18], Hernandez-Gracia *et al*[29] and Mario *et al*[30] have reported a mean time from intubation to tracheostomy of 12.2, 13.9, 10.6, 19.7, 12, 17 and 15 days, respectively. In our study, the mean intubation to open tracheostomy time was 11.97 days and in 47.9% (n = 35) of COVID-19 patients tracheotomies were performed within 10 days of intubation.

The subgroup analysis of tracheostomy among non-survivors and survivors showed that the mean age of non-survivors was higher than survivors. This poor outcome in older patients with tracheostomies is consistent with many studies published on COVID-19[1,18]. Similarly, non-survivors with tracheostomies were suffering from severe COVID-19, which was also consistent with previously published research. Furthermore, most of the non-survivors in our study had late tracheostomy demonstrating poor outcome in patients with late tracheostomy (beyond 10 days), which may be due to worsening of the disease at later stages. However, Tang *et al*[16] suggested better outcomes in tracheostomies done after 14 days whereas Aviles-Jurado *et al*[31] in their prospective study on the safety of tracheostomy reported that early tracheostomy (< 10 days) had no association with mortality. Other parameters such as the number of days from admission to tracheostomy, duration of ICU, and hospital stay were not significantly different between survivors and non-survivors. The overall mortality in our study was 71.2%, which was consistent with other studies reporting > 50% mortality in COVID-19 patients on mechanical ventilation[32,33].

Limitations

Our study had several limitations. First, it was a retrospective observational study with a relatively small sample size. Therefore, a well-designed multicentre randomized controlled trial with adequate sample size is needed to validate the findings in our study. Second, due to its retrospective nature, some

key statistical tests could not be performed. Thirdly, the various scores used in the ICU in predicting the outcome were not analysed. Lastly, we were unable to retrieve and calculate the incidence of complications associated with a tracheostomy. The present study may help other clinicians in designing a clinical trial for future research to identify the best time of tracheostomy in critically ill mechanically ventilated patients.

CONCLUSION

Our study describes the clinical characteristics and outcome of a cohort of patients who underwent tracheostomy after intubation due to COVID-19. The results showed that early tracheostomy (less than 10 days) was associated with reduced mortality. However, a well-designed randomized multicentre trial is needed to elucidate the potential benefit of early tracheostomy in mechanically ventilated COVID-19 patients. We also suggest that the timing of tracheostomy be decided on a case-by-case basis rather than following a strict rule.

ARTICLE HIGHLIGHTS

Research background

The rapid increase in Coronavirus disease 2019 (COVID-19) patients has resulted in an increased number of patients with severe disease requiring prolonged ventilatory support and subsequently tracheostomy. Details regarding the timing, and safety of tracheostomy in the management of COVID-19 patients continue to evolve.

Research motivation

With the limited availability of literature regarding the outcomes of COVID-19 patients with tracheostomy, we attempted to study the clinical characteristics and multiple parameters affecting the outcomes in these patients.

Research objectives

Our research objective was to determine the all-cause mortality after tracheostomy and its relation with various risk factors in COVID-19 patients.

Research methods

We conducted a retrospective observational study at a tertiary care hospital. The study included 73 adult COVID-19 patients admitted to the ICU between 1 April, 2020 and 30 September, 2021 who underwent tracheostomy as a result of acute respiratory failure due to COVID-19.

Research results

Seventy-three adult patients were included in the study with an average age of 52 ± 16.67 years, of which 52% were male. The average time for admission to tracheostomy was 18.12 ± 12.98 days while intubation to tracheostomy was 11.97 ± 9 days. The mortality rate was 71.2% and only 28.8% of patients were discharged alive. Greater age, severe COVID-19, mechanical ventilation, presence of shock and acute kidney injury were associated with a poor prognosis; however, early tracheostomy in intubated patients resulted in a better outcome.

Research conclusions

The study showed that early tracheostomy (less than 10 days) was associated with reduced mortality with no added risk to the patient. Furthermore, the timing of tracheostomy should be decided on a case-by-case basis rather than following a strict rule.

Research perspectives

A well designed randomised controlled trial should be performed to elucidate the potential benefit of early tracheostomy in COVID-19 patients.

FOOTNOTES

Author contributions: Singh A, Soni KD, Aggarwal R, Singh Y, Patel N, Kumar K, Chaudhary N, Perveen F, and Trikha A contributed to conception, study design, as well as data collection and evaluation; Singh A and Soni KD contributed to statistical analysis, and interpretation of data; Singh A, Singh Y, and Trikha A drafted the manuscript, which was revised by Soni KD; all authors have read and approved the final manuscript.

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REFERENCES

1 **Wu Z**, McGoogan JM. Characteristics of and Important Lessons From the Coronavirus Disease 2019 (COVID-19) Outbreak in China: Summary of a Report of 72 314 Cases From the Chinese Center for Disease Control and Prevention. *JAMA* 2020; **323**: 1239-1242 [PMID: 32091533 DOI: 10.1001/jama.2020.2648]
2 **Möhlenkamp S**, Thiele H. Ventilation of COVID-19 patients in intensive care units. *Herz* 2020; **45**: 329-331 [PMID: 32313971 DOI: 10.1007/s00059-020-04923-1]
3 **Scales DC**, Ferguson ND. Tracheostomy: it's time to move from art to science. *Crit Care Med* 2006; **34**: 3039-3040 [PMID: 17130697 DOI: 10.1097/01.CCM.0000242924.24342.9D]
4 **Bösel J**, Schiller P, Hook Y, Andes M, Neumann JO, Poli S, Amiri H, Schönenberger S, Peng Z, Unterberg A, Hacke W, Steiner T. Stroke-related Early Tracheostomy versus Prolonged Orotracheal Intubation in Neurocritical Care Trial (SETPOINT): a randomized pilot trial. *Stroke* 2013; **44**: 21-28 [PMID: 23204058 DOI: 10.1161/STROKEAHA.112.669895]
5 **Robba C**, Galimberti S, Graziano F, Wiegers EJA, Lingsma HF, Iaquaniello C, Stocchetti N, Menon D, Citerio G; CENTER-TBI ICU Participants and Investigators. Tracheostomy practice and timing in traumatic brain-injured patients: a CENTER-TBI study. *Intensive Care Med* 2020; **46**: 983-994 [PMID: 32025780 DOI: 10.1007/s00134-020-05935-5]
6 **Tran K**, Cimon K, Severn M, Pessoa-Silva CL, Conly J. Aerosol generating procedures and risk of transmission of acute respiratory infections to healthcare workers: a systematic review. *PLoS One* 2012; **7**: e35797 [PMID: 22563403 DOI: 10.1371/journal.pone.0035797]
7 **Khanna P**, Garg H, Singh Y. Tracheostomy in Patients with Coronavirus Disease 2019: An Overview. *Turk J Anaesthesiol Reanim* 2021; **49**: 273-277 [PMID: 35110007 DOI: 10.5152/TJAR.2020.950]
8 **McGrath BA**, Brenner MJ, Warrillow SJ, Pandian V, Arora A, Cameron TS, Añon JM, Hernández Martínez G, Truog RD, Block SD, Lui GCY, McDonald C, Rassekh CH, Atkins J, Qiang L, Vergez S, Dulguerov P, Zenk J, Antonelli M, Pelosi P, Walsh BK, Ward E, Shang Y, Gasparini S, Donati A, Singer M, Openshaw PJM, Tolley N, Markel H, Feller-Kopman DJ. Tracheostomy in the COVID-19 era: global and multidisciplinary guidance. *Lancet Respir Med* 2020; **8**: 717-725 [PMID: 32422180 DOI: 10.1016/S2213-2600(20)30230-7]
9 **Miles BA**, Schiff B, Ganly I, Ow T, Cohen E, Genden E, Culliney B, Mehrotra B, Savona S, Wong RJ, Haigentz M, Caruana S, Givi B, Patel K, Hu K. Tracheostomy during SARS-CoV-2 pandemic: Recommendations from the New York Head and Neck Society. *Head Neck* 2020; **42**: 1282-1290 [PMID: 32304119 DOI: 10.1002/hed.26166]
10 **Chao TN**, Braslow BM, Martin ND, Chalian AA, Atkins J, Haas AR, Rassekh CH; Guidelines from the COVID-19 Tracheotomy Task Force, a Working Group of the Airway Safety Committee of the University of Pennsylvania Health System. Tracheotomy in Ventilated Patients With COVID-19. *Ann Surg* 2020; **272**: e30-e32 [PMID: 32379079 DOI: 10.1097/SLA.0000000000003956]
11 **David AP**, Russell MD, El-Sayed IH, Russell MS. Tracheostomy guidelines developed at a large academic medical center during the COVID-19 pandemic. *Head Neck* 2020; **42**: 1291-1296 [PMID: 32329926 DOI: 10.1002/hed.26191]
12 **Givi B**, Schiff BA, Chinn SB, Clayburgh D, Iyer NG, Jalisi S, Moore MG, Nathan CA, Orloff LA, O'Neill JP, Parker N,

Zender C, Morris LGT, Davies L. Safety Recommendations for Evaluation and Surgery of the Head and Neck During the COVID-19 Pandemic. *JAMA Otolaryngol Head Neck Surg* 2020; **146**: 579-584 [PMID: 32232423 DOI: 10.1001/jamaoto.2020.0780]

13 **Takhar A**, Walker A, Tricklebank S, Wyncoll D, Hart N, Jacob T, Arora A, Skilbeck C, Simo R, Surda P. Recommendation of a practical guideline for safe tracheostomy during the COVID-19 pandemic. *Eur Arch Otorhinolaryngol* 2020; **277**: 2173-2184 [PMID: 32314050 DOI: 10.1007/s00405-020-05993-x]

14 **Schultz MJ**, Pattnaik R, Dondorp AM. Walking the line between benefit and harm from tracheostomy in COVID-19. *Lancet Respir Med* 2020; **8**: 656-657 [PMID: 32422179 DOI: 10.1016/S2213-2600(20)30231-9]

15 **COVID-ICU Group on behalf of the REVA Network and the COVID-ICU Investigators**. Clinical characteristics and day-90 outcomes of 4244 critically ill adults with COVID-19: a prospective cohort study. *Intensive Care Med* 2021; **47**: 60-73 [PMID: 33211135 DOI: 10.1007/s00134-020-06294-x]

16 **Tang Y**, Wu Y, Zhu F, Yang X, Huang C, Hou G, Xu W, Hu M, Zhang L, Cheng A, Xu Z, Liu B, Hu S, Zhu G, Fan X, Zhang X, Yang Y, Feng H, Yu L, Wang B, Li Z, Peng Y, Shen Z, Fu S, Ouyang Y, Xu J, Zou X, Fang M, Yu Z, Hu B, Shang Y. Tracheostomy in 80 COVID-19 Patients: A Multicenter, Retrospective, Observational Study. *Front Med (Lausanne)* 2020; **7**: 615845 [PMID: 33425960 DOI: 10.3389/fmed.2020.615845]

17 **Volo T**, Stritoni P, Battel I, Zennaro B, Lazzari F, Bellin M, Michieletto L, Spinato G, Busatto C, Politi D, Spinato R. Elective tracheostomy during COVID-19 outbreak: to whom, when, how? *Eur Arch Otorhinolaryngol* 2021; **278**: 781-789 [PMID: 32656673 DOI: 10.1007/s00405-020-06190-6]

18 **Martin-Villares C**, Perez Molina-Ramirez C, Bartolome-Benito M, Bernal-Sprekelsen M; COVID ORL ESP Collaborative Group (*). Outcome of 1890 tracheostomies for critical COVID-19 patients: a national cohort study in Spain. *Eur Arch Otorhinolaryngol* 2021; **278**: 1605-1612 [PMID: 32749607 DOI: 10.1007/s00405-020-06220-3]

19 **Rosano A**, Martinelli E, Fusina F, Albani F, Caserta R, Morandi A, Dell'Agnolo P, Dicembrini A, Mansouri L, Marchini A, Schivalocchi V, Natalini G. Early Percutaneous Tracheostomy in Coronavirus Disease 2019: Association With Hospital Mortality and Factors Associated With Removal of Tracheostomy Tube at ICU Discharge. A Cohort Study on 121 Patients. *Crit Care Med* 2021; **49**: 261-270 [PMID: 33201005 DOI: 10.1097/CCM.0000000000004752]

20 **Adly A**, Youssef TA, El-Begermy MM, Younis HM. Timing of tracheostomy in patients with prolonged endotracheal intubation: a systematic review. *Eur Arch Otorhinolaryngol* 2018; **275**: 679-690 [PMID: 29255970 DOI: 10.1007/s00405-017-4838-7]

21 **Whited RE**. A prospective study of laryngotracheal sequelae in long-term intubation. *Laryngoscope* 1984; **94**: 367-377 [PMID: 6700353 DOI: 10.1288/00005537-198403000-00014]

22 **Andriolo BN**, Andriolo RB, Saconato H, Atallah ÁN, Valente O. Early versus late tracheostomy for critically ill patients. *Cochrane Database Syst Rev* 2015; **1**: CD007271 [PMID: 25581416 DOI: 10.1002/14651858.CD007271.pub3]

23 **Griffiths J**, Barber VS, Morgan L, Young JD. Systematic review and meta-analysis of studies of the timing of tracheostomy in adult patients undergoing artificial ventilation. *BMJ* 2005; **330**: 1243 [PMID: 15901643 DOI: 10.1136/bmj.38467.485671.E0]

24 **Siempos II**, Ntaidou TK, Filippidis FT, Choi A. Effect of early vs late or no tracheostomy on mortality and pneumonia of critically ill patients receiving mechanical ventilation: a systematic review and meta-analysis. Lancet Respir Med 2015; 3:150-8 [DOI: 10.1016/S2213-2600(15)00007-7]

25 **Young D**, Harrison DA, Cuthbertson BH, Rowan K; TracMan Collaborators. Effect of early vs late tracheostomy placement on survival in patients receiving mechanical ventilation: the TracMan randomized trial. *JAMA* 2013; **309**: 2121-2129 [PMID: 23695482 DOI: 10.1001/jama.2013.5154]

26 **Kwak PE**, Connors JR, Benedict PA, Timen MR, Wang B, Zhang Y, Youlios S, Sureau K, Persky MJ, Rafeq S, Angel L, Amin MR. Early Outcomes From Early Tracheostomy for Patients With COVID-19. *JAMA Otolaryngol Head Neck Surg* 2021; **147**: 239-244 [PMID: 33331855 DOI: 10.1001/jamaoto.2020.4837]

27 **Queen Elizabeth Hospital Birmingham COVID-19 airway team**. Safety and 30-day outcomes of tracheostomy for COVID-19: a prospective observational cohort study. *Br J Anaesth* 2020; **125**: 872-879 [PMID: 32988602 DOI: 10.1016/j.bja.2020.08.023]

28 **Angel L**, Kon ZN, Chang SH, Rafeq S, Palasamudram Shekar S, Mitzman B, Amoroso N, Goldenberg R, Sureau K, Smith DE, Cerfolio RJ. Novel Percutaneous Tracheostomy for Critically Ill Patients With COVID-19. *Ann Thorac Surg* 2020; **110**: 1006-1011 [PMID: 32339508 DOI: 10.1016/j.athoracsur.2020.04.010]

29 **Hernández-García E**, Martínez-RuizCoello M, Navarro Mediano A, Pérez-Martín N, García-Peces V, Velayos C, Rodríguez-Campoo B, Plaza G. Open Tracheostomy for Critically Ill Patients with COVID-19. *Int J Otolaryngol* 2020; **2020**: 8861013 [PMID: 34966431 DOI: 10.1155/2020/8861013]

30 **Turri-Zanoni M**, Battaglia P, Czaczkes C, Pelosi P, Castelnuovo P, Cabrini L. Elective Tracheostomy During Mechanical Ventilation in Patients Affected by COVID-19: Preliminary Case Series From Lombardy, Italy. *Otolaryngol Head Neck Surg* 2020; **163**: 135-137 [PMID: 32396455 DOI: 10.1177/0194599820928963]

31 **Avilés-Jurado FX**, Prieto-Alhambra D, González-Sánchez N, de Ossó J, Arancibia C, Rojas-Lechuga MJ, Ruiz-Sevilla L, Remacha J, Sánchez I, Lehrer-Coriat E, López-Chacón M, Langdon C, Guilemany JM, Larrosa F, Alobid I, Bernal-Sprekelsen M, Castro P, Vilaseca I. Timing, Complications, and Safety of Tracheotomy in Critically Ill Patients With COVID-19. *JAMA Otolaryngol Head Neck Surg* 2020 [PMID: 33034625 DOI: 10.1001/jamaoto.2020.3641]

32 **Godeau D**, Petit A, Richard I, Roquelaure Y, Descatha A. Return-to-work, disabilities and occupational health in the age of COVID-19. *Scand J Work Environ Health* 2021; **47**: 408-409 [PMID: 34003294 DOI: 10.1016/S0140-6736(20)30566-3]

33 **Yang X**, Yu Y, Xu J, Shu H, Xia J, Liu H, Wu Y, Zhang L, Yu Z, Fang M, Yu T, Wang Y, Pan S, Zou X, Yuan S, Shang Y. Clinical course and outcomes of critically ill patients with SARS-CoV-2 pneumonia in Wuhan, China: a single-centered, retrospective, observational study. *Lancet Respir Med* 2020; **8**: 475-481 [PMID: 32105632 DOI: 10.1016/S2213-2600(20)30079-5]

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