Relationship between Tracheostomy and Ventilator-associated Pneumonia in Intensive Care

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Abstract

Tracheostomy is one of the most frequently performed surgical procedures in intensive care units (ICUs) for preventing complications caused by prolonged mechanical ventilation. Tracheostomy is advised to remove tracheobronchial secretions, facilitate weaning, and promote early oral feeding. Ventilator-associated pneumonia (VAP) is hospital-acquired pneumonia that develops 48 h after endotracheal intubation in patients without pneumonia at the beginning of intubation. VAP is a significant cause of mortality and morbidity, particularly in critically ill patients. In addition to its already known advantages, it is a debatable issue whether tracheostomy is a risk factor for VAP. The timing of the procedure is a topic that has been discussed in the literature. Previous studies have revealed that tracheostomy can be performed when the predicted intubation duration is 2 weeks or more. In this review, early or late tracheostomy and its effect on VAP development in ICUs will be discussed along with current literature.

Keywords: Tracheostomy, ventilator-associated pneumonia, mechanical ventilation

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Introduction

Ventilator-associated pneumonia (VAP) is the most frequently encountered infection in ICUs in critical patients receiving mechanical ventilation (MV) support. VAP is defined as nosocomial pneumonia that develops after 48 hours of invasive MV in patients without pneumonia prior to intubation and it occurs in approximately 8%-28% of intubated patients (1, 2). In general, it is more frequently observed in medical ICU patients when compared to surgical ICU patients. It is a significant cause of morbidity and mortality in critical patients. The mortality rates vary between 24% and 50% and in some cases, they may increase up to 76% (3). Causative microorganisms vary by the characteristics of ICU (medical-surgical), patient population, duration of stay in ICU and underlying diseases. The most frequently detected microorganisms are *Pseudomonas aeruginosa, Staphylococcus aureus, Enterobacteriaceae* and *Acinetobacter baumanii* in our country (4). The most important risk factor for VAP development is the duration of stay on MV. Reintubation, severity of the acute disease (Acute Physiology and Chronic Health Evaluation II- APACHE II Score), presence of organ failure, bedsite position, state of consciousness, underlying diseases, presence of a chronic disease in lungs, previous hospitalizations and history of antibiotic use are are among the known risk factors (5).

In recent years, tracheostomy implementation has increased with the development of percutaneous techniques in patients predicted to be subjected to MV for a long time in ICUs (6). Tracheotomy means the surgical opening of the trachea front wall, however, tracheostomy is to create a similar opening and then to fix the trachea to the neck skin. During surgical tracheostomy trachea can be observed directly, as well as the dissection of pretracheal tissues and the placement of the tracheal cannula. It can be performed in the operating room or at the patient's bedside. Percutaneous tracheostomy defines the placement of the tracheal cannula with blunt dissection of the pretracheal tissues by using the Seldinger technique as a guide. In general, tracheostomy aims to provide a more accurate opening. Nowadays, these two terms are interchangeable. Thus, the term of tracheostomy is used in our in this manuscript.

It is still argued when tracheostomy will be performed to which patient with which method. The main purpose of applying tracheostomy to critical patients in intensive care is to prevent complications such as tracheal stenosis due to prolonged intubation, tooth damage, paranasal sinus obstruction, sinusitis, mouth-lip injuries, laryngeal trauma, and cricoid damage. Moreover, prolonged translaryngeal intubation has also life-threatening risks such as accidental extubation and obstruction due to a plug in the endotracheal tube, etc. The risk of these complications increases as the duration of translaryngeal intubation increases. Tracheostomy has many potential benefits such as easier tube maintenance, secretion control, allowing patient communication due to the specific cannula, enabling oral feeding, easier and safer nursing care (7-9). Moreover, it decreases airway resistance, accelerates the weaning process from MV and decreases the duration of hospitalization and and length of ICU stay when compared to the translaryngeal tube. If it is predicted that translaryngeal intubation will last longer than a few weeks, in general, tracheostomy is suggested (10, 11).

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The effect of tracheostomy on VAP development has not been completely enlightened yet. While it is recently suggested that early tracheostomy will make bronchial cleaning easier, facilitate patient mobilization and decrease bronchial epithelial damage in patients predicted to stay intubated for a long time, it is also argued that it may increase the VAP risk due to the direct damage caused to airways and possible microbial entry during the procedure (12). There is a limited number of publications in the literature on the relationship between the time of tracheostomy and duration of VAP development. While there are studies indicating that the VAP rate is low in patients with tracheostomy (13-16), there are also studies suggesting that it is a risk factor for the VAP development (17-19). On the other hand, no effect on the VAP development has been identified in some studies (20, 21). In this review, the effect of tracheostomy opening and its timing in critical patients in ICU on the VAP development will be discussed in the light of current studies.

1. The Relationship between the Time of Tracheostomy and Mechanical Ventilation Duration and Mortality

In spite of the definitions of recently developed ventilator-associated cases to be used in surveillance definitions, there are not accurate criteria related to the clinical and diagnostic definition of VAP. Although there are many clinical methods suggested, none of them has sufficient sensitivity and specificity for the final diagnosis of VAP. The evaluation performed with daily bedside chest radiography may provide assistance for the presence or absence of VAP. However, it does not ensure making a final diagnosis (22). Shan et al. (23) described the Clinical Pulmonary Infection Score (CPIS) for the clinical diagnosis of VAP. This clinical scoring used in many studies on tracheostomy and VAP considers physiological, clinical, microbiological and radiological criteria. Scoring varies between 0 and 12 and scoring ≥6 indicates good correlation with the presence of VAP. Just as it is hard to make a diagnosis of VAP in patients with tracheostomy, it is also difficult to establish a relationship between tracheostomy time and VAP. This is because, in many studies conducted, the time elapsing until tracheostomy and VAP development after tracheostomy is variable and it is difficult to evaluate the clear effect of tracheostomy itself in the light of the current literature.

Considering the VAP pathophysiology in intubated patients, it is possible to say that patients subjected to tracheostomy have a decreased risk of VAP when compared to translaryngeal intubated patients. There are many factors supporting this hypothesis. Endotracheal tube in intubated patients causes aspiration of contaminated oropharyngeal secretions. This colonization is the most significant risk factor for the VAP development (24). The movement and normal opening and closing of vocal cords in patients subjected to tracheostomy decrease the aspiration of oropharyngeal secretions. Furthermore, endotracheal tube constitutes a surface for the bacterial biofilm formation. The periodical change of tracheostomy cannula may decrease the risk of the formation of this bacterial biofilm. Moreover, it is indicated in many studies that tracheostomy makes the weaning from MV easier, shortens the MV duration and decreases the duration of stay in ICU (25, 26). MV duration which is the most important risk factor for VAP has been evaluated in most of these studies, and the patients have been assessed by being separated into groups of early tracheostomy and late tracheostomy.

In general, early tracheostomy is recommended for critical patients who have difficulty in weaning from MV or who are predicted to need MV for a long time. It is easy to predict prolonged MV need in patients developing respiratory insufficiency due to neuromuscular reasons, with a serious head trauma and intubated due to burn or upper respiratory obstruction. It was stated in the study conducted by Mitton et al. (27) on patients with recent traumatic brain damage that, since the respiratory center of the patients with infratentorial brain damage is affected more, their need for tracheostomy within the first 8 days is higher because dysphagia, difficulty in the secretion control, airway spasm and hypoventilation are more frequently observed in patients with infratentorial brain lesion. It was stated in this study conducted in neurorehabilitation service that patients subjected to early tracheostomy were more successful in terms of weaning from MV when compared to late tracheostomy. In the study conducted by Kim et al. (28), the effects of early and late tracheostomy on patients subjected to decompressive surgery were examined. It was determined that early tracheostomy decreased the duration of antibiotic use for pneumonia treatment in patients with serious brain damage. Bouderka et al. (29) prospectively randomized 62 patients with serious head trauma and with the Glasgow coma score below 8 into groups of early tracheostomy (5th and 6th days, n=31) and prolonged endotracheal intubation (n=31). MV duration was found to be 3 days shorter in the early tracheostomy group. No difference was observed in pneumonia and mortality rate. Although MV duration was found to be short in this study, the method of weaning from MV was not defined.

However, as it is not easy to predict patients who will need prolonged MV in the other critically-ill patient groups, there are currently no clear determinants to identify these patient groups. In the previous studies of Georges et al. (30) and Rello et al. (31), the VAP incidence was stated to be 25% and 18%, respectively, in patients subjected to surgical and percutaneous tracheostomy. In these studies, VAP usually started on the day tracheostomy was performed. However, in these studies, the VAP incidence was not evaluated separately after tracheostomy, before tracheostomy or in patients not subjected to tracheostomy. Non-traumatic patients without immunosuppression and subjected to MV for longer than 7 days were not included in the retrospective case control study conducted by Nseir et al. (14), in which the relationship between tracheostomy and VAP was examined. MV duration and the duration of stay in ICU were found to be shorter in patients subjected to early tracheostomy. In this study, neurological disorder and antibiotic use were found to be the other risk factors for VAP.

In a study conducted recently in our country, in which 203 ICUs were included (87.2% were tertiary, 83.4% were mixed ICU), elective tracheostomy was applied to 5720 (7.1%) of the 80569 patients subjected to MV. The most frequent indication for tracheostomy was found to be prolonged MV. Seventy-nine point eight percent of the tracheostomies were opened percutaneously in ICU. Griggs guide wire dilatating forceps technique (70.4%) was determined to be the most frequently used method. In this study, the fact that tracheostomy made weaning from MV easier was indicated as the most important advantage of it. Considering the timing of tracheostomy, while early tracheostomy was applied within the first week in only 3% of the ICUs in Turkey, tracheostomy was applied in the 2nd or 3rd weeks in 97% of the ICUs (32).

In the TracMan study, the effect of early tracheostomy on mortality in critical patients requiring MV as a primary endpoint was examined. In this multi-centered, open-ended, randomized, controlled study, patients were randomized into two groups as the early tracheostomy group subjected to tracheostomy within the first 4 days (n=445) and the late tracheostomy group subjected to tracheostomy after the 10th day (n=454). While tracheostomy was performed in 91.9% of the patients randomized in the early tracheostomy group (95% CI:89%-94.1%), it was applied in only 44.9% of the patients randomized in the late tracheostomy group (95% CI:40.4%-49.5%). While death due to all reasons on the 30th day after randomization was 30.9% in the early tracheostomy group, it was

31.5% in the late tracheostomy group (A clear decrease in risk; early vs. late 0.7% 95% CI:-5.4%-6.7%). Although VAP incidence was not investigated, in this study having the highest number of patients, no difference was determined between two groups in terms of the antibiotic use [5 (IQR 1-8) vs. 5 (IQR 1-10, p=0.95)] (33).

In the light of all these studies, it can be concluded that early tracheostomy shortens the duration of stay in ICU and decreases the complications in patients who are predicted to be subjected to prolonged intubation. If prolonged mechanical ventilation need is still in question even after the patients are stabilized in mechanical ventilation, tracheostomy should be planned considering the above-mentioned advantages. However, there is no clear interpretation on the VAP incidence. Although early tracheostomy is not frequently performed in ICUs in our country, it is certain that intensive care doctors will be more inclined to early tracheostomy, with the widespread availability of percutaneous tracheostomy. Due to the fact that percutaneous technique is still developing and many doctors interested in intensive care have not completed the learning curve yet, it is possible to provide assistance from otorhinolaryngologists for surgical tracheostomy. However, it is estimated that percutaneous tracheostomy will become prevalent due to experience and familiarization increasing over time. Considering the advantages of early tracheostomy, it is important for intensive care doctors to improve themselves in this regard.

2. Time of Tracheostomy and Ventilator-Associated Pneumonia

The VAP incidence is indicated to be between 6%-26% in patients with tracheostomy (1). In the current studies, the duration between tracheostomy application and VAP development is considerably variable, and there is no specific time indicated. In the study conducted by Nseir et al. (14), VAP developing within the first 5 days after the start of MV was accepted as early VAP, and VAP developing after 5 days was accepted as late VAP. The average MV days before tracheostomy were found to be 21 (±12) days. Tracheostomy was performed in 72% of the patients (128/177) 7 days after the start of MV. One hundred seventy-eight VAP episodes were observed in 124 patients in total (84% late-onset VAP). Sixty-nine VAP episodes in total occurred after tracheostomy was performed. The average duration between MV onset and first VAP episode was determined to be 15±10 days. The average duration between tracheostomy in the control patient group or related MV days and first VAP episode was found to be 4.5±2.1 vs. 4.9±2.5 days (p=0.514). Previous antibiotic use, neurological disorder, antibiotic use during ICU hospitalization, duration of the antibiotic use during ICU hospitalization and tracheostomy were determined to be factors related to VAP as a result of a univariate analysis. Neurological disorder and antibiotic use during ICU hospitalization were identified as independent risk factors increasing VAP. On the other hand, tracheostomy was found to be an independent risk factor decreasing the VAP risk.

In the retrospective study they conducted, Turkovic et al. (34) compared three different patient groups, being those without tracheostomy before the VAP development, those never subjected to tracheostomy and those subjected to tracheostomy after the VAP development. No difference was determined among the groups in terms of the reason for MV or tracheostomy, number of re-intubation, number of MV days, ICU hospitalization days, corticosteroid and antibiotic use before tracheostomy. In the study in which 453 intubated patients in total were included, tracheostomy was performed in 178 (39%) patients during the ICU hospitalization period. While tracheostomy was performed in 98 patients of the 113 patients (25%) before the VAP development, it was performed in 15 patients after the VAP development. The SAPS II and APACHE II scores of patients without tracheostomy after the VAP development were found to be higher when compared to those with tracheostomy before the VAP development (p=0.024). Most of the patients (60%, 46/77) with tracheostomy constituted ICU admission related to neurosurgery. In this study conducted by Turkovic et al. (34), mortality was found to be two times more in patients not subjected to tracheostomy during the ICU hospitalization when compared to the patients subjected to tracheostomy before or after the VAP development. Corticosteroid use and MV duration were determined to be other factors increasing mortality. The MV duration and duration of stay in ICU until the VAP development were found to be 2 times longer in the group subjected to tracheostomy before VAP when compared to the group not subjected to tracheostomy before or after VAP. The VAP incidence in ICU was determined to be 25% during the study. Tracheostomy decreased the risk of VAP development by 67% (Relative risk 0.33, 95% CI:0.20-0.56). In the study group, VAP developed in 34% (98/290) of those not subjected to tracheostomy and in 9% (9/163) of those subjected to tracheostomy.

The effect of tracheostomy on mortality, MV duration and VAP incidence in critical patients were also evaluated with meta-analyses. Firstly, Durbin et al. (35) evaluated 7 studies examining 641 patients by separating them into the groups of early tracheostomy (n=311) or prolonged endotracheal intubation or late tracheostomy (n=330) in 2010. In six of these studies, tracheostomy was performed within the first 5 days. Cross randomization was performed in two studies, and methodological limitations were identified. When all studies were included and evaluated, it was found out that early tracheostomy did not affect mortality (OR:0.79, 95% CI:0.3-1.45) and VAP risk (OR:0.67, 95% CI:0.36-1.23). When meta-analysis was decreased to 5 studies (when the studies in which tracheostomy was performed within the first 5 days were included), it was observed that it had no effect on mortality (OR:0.66, 95% CI:0.37-1.17), VAP development (OR:0.62, 95% CI:0.3-1.3) and MV duration (OR:-7.32 days, 95% CI:-15.3-0.65).

In the meta-analysis conducted by Wang et al. (36) in 2012, the effect of early tracheostomy, prolonged translaryngeal intubation and tracheostomy performed following prolonged translaryngeal intubation on clinical results in critical patients was examined. Early tracheostomy was described as tracheostomy performed within the first 7 days. The primary endpoint was determined as short-term mortality and VAP incidence. 7 studies were included in the meta-analysis, and 1044 patients in total were examined. Early tracheostomy did not significantly decrease hospital mortality and short-term mortality (RR:0.86, 95% CI:0.65-1.13, p=0.28) defined as 90-day mortality and VAP incidence (RR:0.94, 95% CI:0.77-1.15, p=0.54). It was observed that there were data on mechanical ventilation in 4 studies (n=442) and early tracheostomy did not reduce MV duration in these studies (WMD:-3.9 days, 95% CI:-9.71-1.91, p=0.19). Although this meta-analysis is significant in terms of the number of patients, the patient groups included in the studies are heterogeneous. Another limitation is that the definitions of early tracheostomy and late tracheostomy are variable. Tracheostomy was performed between 2nd and 8th days in the early tracheostomy group and between 14th and 28th days in the late tracheostomy group.

In the study conducted by Rumbak et al. (13), performing tracheostomy within the first two days after ICU admission to ICU decreased mortality rate, VAP incidence and length of ICU stay more when compared to the patients subjected to tracheostomy between the 14th and 16th days. Although the method of weaning from MV was described in this study, the average MV duration was more than the average length of ICU stay. The reason for this is the fact that the group subjected to tracheostomy was transferred from ICU earlier.

Table 1. Studies evaluating the tracheostomy timing in various intensive care units, and mechanical ventilation duration and ventilator-associated pneumonia rate

Study, year	Study Design	Intensive Care Type	Number of Patients		Time of Tracheostomy		Tracheostomy Type	Mechanical Ventilation Duration (early vs. late, day)	Definition of VAP	Pneumonia Rate
			Early	Late	Early	Late				
Saffle et al. (2002)(38)	Prospective, randomized	Burn ICU	21	23	Immediately after operation	>14th day	Surgical tracheostomy mostly in the operating room	35.5 (4.5) vs. 31.4 (5.2) (p>0.05)	CDC criteria	21 (100%) vs. 22 (96%) (p>0.05)
Bouderka et al. (2004) (29)	Prospective, randomized	Neurosurgery ICU	31	31	5-6th day	Prolonged intubation	Not specified	Shorter MV duration after VAP development 6±4.7 vs. 11.7±6.7 days (p=0.01)	CDC Criteria	No difference in terms of VAP frequency
Rumbak et al. (2004) (13)	Prospective, randomized	Medical ICU	60	60	0-2nd day	14-16th day day	PDT	7.6 (4.0) vs. 17.4 days (5.3) (p<0.01)	Culture positivity in reinforced brush and BAL samples with clinical findings	5% vs. 25% (p<001)
Barquist et al. (2006)(39)	Prospective, randomized	Trauma ICU	29	31	<8th day	>28th day	Both in bedside and in the operating room	Early tracheostomy shortened MV duration more than 4.1 days, less than 5%	CDC criteria	28 (96.5%) 31 (90.3%) (p=0.6)
Blot et al. (2008)(40)	Prospective, randomized	Medical-Surgical ICU	61	62	<4th day	>14th day	Surgical tracheostomy mostly in bedside	14 (2–28) vs. 16 (3–28) days (p=0.62)	Culture positivity in respiratory secretions with clinical findings	Total VAP episode 30 (49.2%) vs. 31 (50.0%) (p=0.94)
Terragni et al. (2010)(37)	Prospective, randomized	General ICU	209	210	6-8th day	13-15th day	Bedside percutaneous tracheostomy	The number of days without MV: without MV: 11 (0-21) vs. 6 (0-17) days (p=0.02).	Simplified CPIS criteria (>6 CPIS VAP Positive)	30 (14%; 95% CI 10%-19%) vs. 44 (21%; 95% CI 15%-26%) (p=.07). Hazard rate for VAP development 0.66 (95% CI, 0.42-1.04)
Trouillet et al. (2011)(41)	Single-centered, Prospective, randomized controlled	ICU after cardiac surgery	109	107	Within 5 days After surgery	>15th day	Bedside percutaneous tracheostomy	17.9 (14.9) vs. 19.3 (16.9) (p=0.55)	BAL culture positivity with clinical findings	50 (46%) vs. 47 (64.4%) (95% CI 2.0, - 11.3- 15.2) (p=0.77)
Zheng et al. (2012)(42)	Single-centered, Prospective, randomized	Surgical ICU	58	51	3rd day	>15th day	PDT	The number of days without MV: 9.57±5.64 vs. 7.38± 6.17 days (p< 0.05).		17 (29.3%) vs. 30 (49.2%) (p<0.05)
Koch et al. (2012)(42)	Prospective, randomized	Surgical, Neurosurgery, Neurology ICU	50	50	≤4th day	>6th day	PDT	15.3 (9.1–19.8) vs. 21.1 (13.5–27.9) (p ≤0.01)	CPIS score	38% vs. 64%
Young et al. (2013) (33)	Multi-centered, Prospective, Randomized	General and Surgical ICU	451	448	≤4th day	>10th day	Mostly PDT	13.6 (12.0) vs. 15.2 (14.4) (p=0.06)	-	No difference in terms of antibiotic use, VAP incidence is not specified.
Mohamed et al. (2014)(44)	Prospective randomized	Not specified	20	20	≤10th day	>10th day	PDT	20.6 (13.0) vs. 32.2 (10.5) (p<0.01)	Culture positivity in respiratory secretion with clinical findings	4 (20%) vs. 8 (40%) (p=0.167)
Diaz-Prieto et al. (2014)(45)	Prospective randomized	General ICU	245	244	<8th day	>14th day	PDT	Not specified	Culture positivity in CPIS, BAL or tracheal aspirates	33 (13%) vs. 23 (9%) (p=0.160)
Turkovic et al. (2016) (34)	Single-centered, retrospective, observational	Surgical and Neurosurgery ICU	No tracheostomy after the VAP development 36		Tracheostomy after VAP 62	Tracheostomy before VAP 15	Surgical or percutaneous	MV duration until VAP development is longer in patients subjected to tracheostomy before VAP development 7 (3-11) vs. 3 (2-5) vs. 9(6-14), (p<0.001)	CPIS score, culture positivity in tracheal aspirates	Antibiotic use before VAP is 2 (0-3) vs. 1(0-2) less in those subjected to tracheostomy before VAP: vs. 3 (2-5) (p=0.012)

CPIS: Clinical Pulmonary Infection Score; CI: confidence interval; MV: mechanical ventilation; PDT: percutaneous dilatational tracheostomy; ICU: intensive care unit; VAP: ventilator-associated pneumonia; CDC: Center of Disease Control; BAL: bronchoalveoler lavage

In the meta-analysis in which Griffiths et al. (21) examined 406 cases from 5 randomized or cross randomized studies, they found out that early tracheostomy did not affect mortality (RR:0.79, 95% CI:0.45-1.39), and moreover, the risk of pneumonia was not affected by the time of tracheostomy (WMD-8.5 days, 95% CI:-15.3-1.7). Early tracheostomy significantly decreased MV duration (RR:-15.3, 95% CI:-24.6 to -6.1). There is a potential selection bias in this meta-analysis since it includes cross randomization studies.

In the study conducted by Terragni et al. (37), the patient group subjected to tracheostomy between the 6th and 8th days and the group subjected to tracheostomy between the 13th and 15th days were compared in terms of the VAP incidence. While patients with the SAPS II score of 35-65, SOFA score>5 and CPIS<6 were included in this study, the patients with COPD or lung cancer were not included. The presence of VAP was stated with simplified CPIS (21) scoring. This scoring is calculated with tracheal secretions as 0, 1, 2, infiltrations in a chest x-ray, fever, white blood cell count, 0 or 2 of PaO_2/FiO_2 rate (or the presence of ARDS) and microbiological results. At the beginning of the study, CPIS was calculated every 72 hours before and after randomization and until the 28th day of randomization. While the primary endpoint was determined as cumulative VAP incidence on the 28th day, secondary endpoints were identified as the number of days without a ventilator, number of days without ICU and recovery in both groups. 419 patients in total were separated into groups of early tracheostomy (n=209) and late tracheostomy (n=210). VAP developed in 30 patients (14%, 95% CI:10-19%) in the early tracheostomy group and in 44 patients (21%, 95% CI:15-26%) (p=0.07) in the late tracheostomy group. In the early tracheostomy group, the number of days without a ventilator, number of days without ICU and successful weaning from MV and discharge from ICU were found to be significantly higher. No difference was observed in terms of the twenty-eight-day mortality. The hazard ratio was found to be 0.66 (95% CI:0.42-1.04) for VAP development.

Recent studies on tracheostomy and VAP development are summarized in Table 1 (38-45). In the studies in which the Center of Disease Control (CDC) criteria and CPIS were generally used for VAP definition, no difference was determined between the early tracheostomy group and late tracheostomy group in terms of the VAP incidence. Contrary to the results of these studies conducted in different patient groups such as neurosurgery, trauma, neurology, medical and surgical ICU, in the studies conducted by Zheng et al. (42) in surgical ICU, the number of days without a mechanical ventilator in patients subjected to tracheostomy within the first 3 days and VAP rate were found to be lower when compared to the patients subjected to tracheostomy after the 15th day (Table 1).

There is no consensus in the literature on the timing of tracheostomy. Although it has been indicated in the above mentioned studies that early tracheostomy does not cause increased mortality, it is not clear whether early tracheostomy increases VAP risk.

Conclusion

Although tracheostomy was considered a complex surgical procedure that may cause many complications, recently it is being performed more frequently especially with the adoption of percutaneous tracheostomy by intensive care doctors. As a result of the studies examined in this review, the general opinion is that early tracheostomy shortens the length of ICU stay and decreases the duration of mechanical ventilation. There is a need for more randomized controlled studies with broader participation to evaluate the effects of tracheostomy on VAP and mortality in intensive care patients.

References

1. Nair GB, Niederman MS. Ventilator-associated pneumonia: present understanding and ongoing debates. Intensive Care Med 2015; 41: 34-48. [CrossRef]
2. Chastre J, Fagon JY. Ventilator-associated pneumonia. Am J Respir Crit Care Med 2002; 165: 867-903. [CrossRef]
3. Lewis SC, Li L, Murphy MV et al. CDC Prevention Epicenters. Risk factors for ventilator-associated events: a case-control multivariable analysis. Crit Care Med 2014; 42: 1839-48. [CrossRef]
4. Savas L, Onlen Y, Duran N, et al. Causes of nosocomial pneumonia and evaluation of risk factors in a university hospital in Turkey. Saudi Med J 2007; 28: 114-2
5. Pawar M, Mehta Y, Khurana P, et al. Ventilator-associated pneumonia: Incidence, risk factors, outcome, and microbiology. J Cardiothorac Vasc Anesth 2003; 17: 22-8. [CrossRef]
6. Yıldırım F, Güllü YT, Demirel CB. Percutaneous tracheostomy in the intensive care unit. Eurasian J Pulmonol 2015; 17: 136-41.
7. Nieszkowska A, Combes A, Luyt CE, et al. Impact of tracheotomy on sedative administration, sedation level, and comfort of mechanically ventilated intensive care unit patients. Crit Care Med 2005; 33: 2527-33. [CrossRef]
8. Boles JM, Bion J, Connors A, et al. Weaning from mechanical ventilation. Eur Respir J 2007; 29: 1033-56. [CrossRef]
9. Heffner JE. The role of tracheotomy in weaning. Chest 2001; 120: 477-81. [CrossRef]
10. Rello J, Lorente C, Diaz E, et al. Incidence, etiology, and outcome of nosocomial pneumonia in ICU patients requiring percutaneous tracheotomy for mechanical ventilation. Chest 2003; 124: 2239-43. [CrossRef]
11. Frutos-Vivar F, Esteban A, Apezteguia C, et al. Outcome of mechanically ventilated patients who require a tracheostomy. Crit Care Med 2005; 33: 290-8. [CrossRef]
12. Veelo DP, Binnekade JM, Schultz MJ. Tracheostomy - causative or preventive for ventilator-associated pneumonia? Curr Respir Med Rev 2010; 6: 52-7. [CrossRef]
13. Rumbak MJ, Newton M, Truncale T, et al. A prospective, randomized, study comparing early percutaneous dilational tracheotomy to prolonged translaryngeal intubation (delayed tracheotomy) in critically ill medical patients. Crit Care Med 2004; 32: 1689-94. [CrossRef]
14. Nseir S, Di Pompeo C, Jozefowicz E, et al. Relationship between tracheotomy and ventilator-associated pneumonia: a case control study. Eur Respir J 2007; 30: 314-20. [CrossRef]
15. Schneider GT, Christensen N, Doerr TD. Early tracheotomy in elderly patients results in less ventilator-associated pneumonia. Otolaryngol Head Neck Surg 2009; 140: 250-5. [CrossRef]
16. Veelo DP, Bulut T, Dongelmans DA, et al. The incidence and microbial spectrum of ventilator-associated pneumonia after tracheotomy in a selective decontamination of the digestive tract-setting. J Infect 2008; 56: 20-6. [CrossRef]
17. Ibrahim EH, Tracy L, Hill C, et al. The occurrence of ventilator-associated pneumonia in a community hospital: risk factors and clinical outcomes. Chest 2001; 120: 555-61. [CrossRef]
18. Joseph NM, Sistla S, Dutta TK, et al. Ventilator-associated pneumonia in a tertiary care hospital in India: incidence and risk factors. J Infect Dev Ctries 2009; 3: 771-7. [CrossRef]
19. Rocha Lde A, Vilela CA, Cezário RC, et al. Ventilator-associated pneumonia in an adult clinicalsurgical intensive care unit of a Brazilian university hospital: incidence, risk factors, etiology, and antibiotic resistance. Braz J Infect Dis 2008; 12: 80-5. [CrossRef]
20. Blot F, Similowski T, Trouillet JL, et al. Early tracheotomy versus prolonged endotracheal intubation in unselected severely ill ICU patients. Intensive Care Med 2008; 34: 1779-87. [CrossRef]
21. Griffiths J, Barber VS, Morgan L, et al. Systematic review and meta-analysis of studies of the timing of tracheostomy in adult patients undergoing artificial ventilation. BMJ 2005; 330: 1243. [CrossRef]

22. Klompas M, Clinician's Corner. Does this patient have ventilator-associated pneumonia? JAMA 2013; 297: 1583-93. [CrossRef]
23. Shan J, Chen HL, Zhu JH. Diagnostic accuracy of clinical pulmonary infection score for ventilator-associated pneumonia: a meta-analysis. Respir Care 2011; 56: 1087-94. [CrossRef]
24. Cavalcanti M, Valencia M, Torres A. Respiratory nosocomial infections in the medical intensive care unit. Microbes Infect 2005; 7: 292-301. [CrossRef]
25. Freeman BD, Borecki IB, Coopersmith CM, et al. Relationship between tracheostomy timing and duration of mechanical ventilation in critically ill patients. Crit Care Med 2005; 33: 2513-20. [CrossRef]
26. Hsu CL, Chen KY, Chang CH, et al. Timing of tracheostomy as a determinant of weaning success in critically ill patients: a retrospective study. Crit Care 2005; 9: 46-52. [CrossRef]
27. Mitton K, Walton K, Sivan M. Tracheostomy weaning outcomes in relation to the site of acquired brain injury: A retrospective case series. Brain Inj 2017; 31: 267-71. [CrossRef]
28. Kim TH, Kim HS, Yang SH, et al. Early and late tracheostomy after decompressive craniectomy. J Korean Neurotraumatol Society 2009; 5: 89-92. [CrossRef]
29. Bouderka MA, Fakhir B, Bouaggad A, et al. Early tracheostomy versus prolonged endotracheal intubation in severe head injury. J Trauma 2004; 57: 251-4. [CrossRef]
30. Georges H, Leroy O, Guery B, et al. Predisposing factors for nosocomial pneumonia in patients receiving mechanical ventilation and requiring tracheotomy. Chest 2000; 118: 767-74. [CrossRef]
31. Rello J, Lorente C, Diaz E, et al. Incidence, etiology, and outcome of nosocomial pneumonia in ICU patients requiring percutaneous tracheotomy for mechanical ventilation. Chest 2003; 124: 2239-43. [CrossRef]
32. Gucyetmez B, Atalan HK, Cakar N. Turkish Tracheotomy Survey Group. Elective Tracheotomy Practices in Turkey. PLoS One 2016; 11: e0166097. [CrossRef]
33. Young D, Harrison DA, Cuthbertson BH, et al. TracMan Collaborators. Effect of early vs late tracheostomy placement on survival in patients receiving mechanical ventilation: the TracMan randomized trial. JAMA 2013; 309: 2121-9. [CrossRef]
34. Turković TM, Lukić A, Perić M. Early versus late percutaneous tracheotomy in ciritically ill patients: A retrospective single center observational study. Acta Clin Croat 2016; 55: 33-40.
35. Durbin CG Jr. Tracheostomy: Why, when, and how. Respir Care 2010; 55: 1056-68.
36. Wang F, Wu Y, Bo L, et al. The timing of tracheotomy in critically ill patients undergoing mechanical ventilation: A systematic review and meta-analysis of randomized controlled trials. Chest 2011; 140: 1456-65. [CrossRef]
37. Terragni PP, Antonelli M, Fumagalli R, et al. Early vs late tracheotomy for prevention of pneumonia in mechanically ventilated adult ICU patients: a randomized controlled trial. JAMA 2010; 303: 1483-9. [CrossRef]
38. Saffle JR, Morris SE, Edelman L. Early tracheostomy does not improve outcome in burn patients. J Burn Care Rehabil 2002; 23: 431-8. [CrossRef]
39. Barquist ES, Amortegui J, Hallal A, et al. Tracheostomy in ventilator dependent trauma patients: a prospective, randomized intention-to-treat study. J Trauma 2006; 60: 91-7. [CrossRef]
40. Blot F, Similowski T, Trouillet JL, et al. Early tracheotomy versus prolonged endotracheal intubation in unselected severely ill ICU patients. Intensive Care Med 2008; 34: 1779-87. [CrossRef]
41. Trouillet JL, Luyt CE, Guiguet M, et al. Early percutaneous tracheotomy versus prolonged intubation of mechanically ventilated patients after cardiac surgery: a randomized trial. Ann Intern Med 2011; 154: 373-83. [CrossRef]
42. Zheng Y, Sui F, Chen XK, et al. Early versus late percutaneous dilational tracheostomy in critically ill patients anticipated requiring prolonged mechanical ventilation. Chin Med J 2012; 125: 1925-30.
43. Koch T, Hecker B, Hecker A, et al. Early tracheostomy decreases ventilation time but has no impact on mortality of intensive care patients: a randomized study. Langenbecks Arch Surg 2012; 397: 1001-8. [CrossRef]
44. Mohamed KAE, Mousa AY, ElSavy AS, et al. Early versus late percutaneous tracheostomy in critically ill adult mechanically ventilated patients. Egyp J Chest Dis Tubercu 2014; 63: 443-8. [CrossRef]
45. Diaz-Prieto A, Mateu A, Gorriz M, et al. A randomized clinical trial for the timing of tracheotomy in critically ill patients: factors precluding inclusion in a single center study. Crit Care 2014; 18: 585.[CrossRef]