

Review Article

Role of early tracheostomy for preventing ventilator associated pneumonia in intensive care unit: a review

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ABSTRACT

Tracheostomy often plays a crucial role in airway management of the patients in intensive critical unit (ICU). Tracheostomy is often helpful for improvement of the respiratory mechanics and the patient comfort. There are several advantages of the tracheostomy over the endotracheal tube intubation such as avoidance of the injury of the larynx, provide a stable airway, facilitates pulmonary toilet and facilitates ventilation. It has been suggested that tracheostomy also helpful to reduce the risk of ventilator associated pneumonia (VAP) in comparison to the trans-laryngeal intubation. VAP is a type of nosocomial infection which has been associated with presence of mechanical ventilation. Despite significant improvement in managing the intubated patients, VAP remains a common and sometimes fatal complication in the ICU. Clinician's attitude towards tracheostomy may be still heterogeneous in ICU and the decision for performing tracheostomy is still challenging. However, early tracheostomy is associated with less VAP, less ICU stay, avoid higher number of intubation in early group of tracheostomy and higher patient comfort. The purpose of this review article was to discuss the etiopathology of VAP, epidemiology, role of early tracheostomy in VAP and prevention of the VAP in patients with mechanical ventilation in ICU.

Keywords: Ventilator associated pneumonia, Tracheostomy, Mechanical ventilation, Intensive critical care unit

INTRODUCTION

The increasing number of the patients in ICU are well documented in the literature. Tracheostomy is a frequently performed surgical procedure among the critically ill patients in the ICU for reducing the duration of the sedation, increase of the comfort, shortening of the mechanical ventilation and minimizes the ICU stay.¹ Performing early tracheostomy is a significant question for both intensivist and otolaryngologists to minimize the morbidity and mortality of the ICU patients. Prolonged intubated patients without performing of tracheostomy may result in injury of the respiratory tract other complications like ventilator associated pneumonia (VAP) and even sinusitis.² VAP is a fatal complications

associated with intubated patients in the ICU. There are different health care measures are done by intensivist for preventing the VAP such as adequate antibiotic protocols, bacterial decontamination of the oral cavity and pharynx, head positioning, early gastrostomy, hand disinfection, application of microbiological surveillance and monitoring or early removal of the invasive devices.³ Among these protocols, early tracheostomy is an important measure for reducing the risk of the VAP.³ It has been calculated that up to one-third of patients undergo mechanical ventilation at the ICU need tracheostomy.⁴ Early tracheostomy has been suggested for reducing the VAP in comparison to the trans-laryngeal intubation.⁵ However, the data from observational and randomized trial from different parts of the world are

found to be conflicting on relationship between the tracheostomy and VAP. In this review article, we aimed to discuss about the epidemiology, etiopathology of VAP and role of early tracheostomy for preventing the occurrence of VAP.

METHODS FOR LITERATURE SEARCH

For searching the published articles, we conducted an electronic search of the pubmed, medline, scopus and google scholar data bases. Articles regarding ventilator associated pneumonia in ICU patients were searched through a multistage systematic approach. The search term in the data base included VAP, mechanical ventilation, early tracheostomy in preventing ventilator associated pneumonia. The abstracts of the published articles were identified by this search method and other articles were identified manually from citations. Then, we systematically analyzed and reviewed all the literature. This review article presented a baseline from where further prospective trials can be designed and helped as a spur for further research in this fatal clinical entity such as ventilator associated pneumonia and its role for prevention by performing early tracheostomy where not many studies are done on this topic particular.

EPIDEMIOLOGY

VAP is a major clinical factor contributing for morbidity and mortality of the patients in the ICU.⁶ A meta-analysis revealed that the average attributable mortality to VAP is approximately 32.5% in the ICU.⁷ It is documented that from 8 to 28% of the patients with mechanical ventilation develop pneumonia, the risk is between 3 to 10 times higher than the patients those do not receive mechanical ventilation.⁸ Furthermore approximately 90% of episodes of the nosocomial pneumonia documented in the ICU during mechanical ventilation.⁹ A systematic data published revealed the incidence of VAP to be 10-20% with two fold increase in mortality attributable to VAP.¹⁰ A recent study from Canada calculated an additional 4.3 ICU days and estimated national cost of \$43 million per year.¹¹ There were similar study documented by a North American region with increased unadjusted ICU stay and mortality in patients with VAP (50% mortality in VAP patients versus 34% in non-VAP) with an calculated \$11,897 attributable cost.¹² The burden of VAP also takes up a significant part of antibiotic dispensing in the ICU and may be responsible for development of multi-resistant bacteria.¹²

ETIOPATHOLOGY

The presence of the endotracheal tube for long time may contributes to VAP through two mechanisms such as first through microaspiration of secretion which contain pathogenic micro-organisms and secondly via formation of a biofilm (Figure 1). The endotracheal tube after intubation breach the anatomical barriers formed by the larynx and glottis. Suppression of the cough reflexes are

usually due to sedation which further hampers the natural reflexes.¹³ The nasal cavities, paranasal sinuses, oropharynx and the stomach have been proposed as reservoirs of infective materials.¹⁴ The aspiration of contaminated secretions leads to lower airway colonization and subsequent infection of the lungs.¹⁵ In addition to this, it is thought that liberation of the vocal folds in tracheostomised patients favours normal vocal fold closure and so reduces the risk of aspiration of the secretions from the oropharynx. Tracheostomy also facilitates the clearance of the airway from the secretions and weaning from the mechanical ventilation and so reduces the duration of mechanical ventilation and ICU stay which are two important risk factors for VAP.¹⁶ Dental plaques also act as an important reservoir for the respiratory pathogens associated with VAP.¹⁷ In transoral endotracheal tube, it hides the oral cavity and prevents the access for proper oral care. Nurses also avoid the oral care for fear of dislodgement of the endotracheal tube. The transoral endotracheal tube keeps mouth open and predisposes to xerostomia which leads to poor oral hygiene.¹⁷ Microbial biofilm are often found on the luminal surface of the endotracheal tubes of patients those mechanically ventilated in the ICU and this biofilm formed within hours of tracheal intubation and it abundant in 96 hours.¹⁸ Microbial biofilm may act as a reservoir of the pathogens resulting recurrent infections. One study showed that 70% of patients with VAP had similar pathogens isolated from their tracheal endotracheal tube and lower respiratory tract.¹⁹ Furthermore, the biofilm are often associated with developing microbial bacterial resistance.¹⁹

VENTILATOR ASSOCIATED PNEUMONIA

VAP is the 2nd most common infection among patients admitted in the ICU.²⁰ VAP is usually associated with prolonged period of the mechanical ventilation and increased ICU stay which increases the requirement for the human resources and burden of the cost in the ICU.²¹ VAP is an important determinant for outcome of the critically ill patients in the ICU. Patients those experience VAP in ICU have higher chance of death in comparison to the patients without this disease.²² VAP is often acquired in the patients in approximately 48 to 72 hours after mechanical ventilation.²³ The main objective of the mechanical ventilation was to help towards the gas exchange without resulting injury to the lungs. However, mechanical ventilation can cause injury to the lungs by stress and strain developed in the lungs. High pressure and high volume can lead to barotrauma and volutrauma to the lungs which is again followed by biotrauma and atelectrauma.²⁴ Normally the respiratory system clears the secretions from the pharynx and larynx either by cough reflex or mucociliary action. However, the mechanically ventilated patients are unconscious and there is clearance of the secretions of the oropharynx because of the failure of the physiological mechanism. The immune mechanism is also not effective in patient with lower immune response.²⁵ The normal bacterial

colonies of the oral cavity increases in number in the intubated patients in ICU. These colonies along with secretions pass along the endotracheal tube. It also forms a biofilm and reaches the distal part of the airway resulting to pneumonia.²⁶ Early tracheostomy may be helpful for rapid weaning from the mechanical ventilation, which will reduce the duration of the mechanical ventilation. In one randomized trial in patients of head injury, the duration of mechanical ventilation needed after VAP was reduced significantly in patients with those underwent tracheostomy on the fifth ICU day in comparison to the 15th ICU day.²⁷ VAP is an important and fatal clinical entity seen among the critically ill patients in the ICU. Patients those present with VAP may show a greater risk of morbidity of the patients and even cause death in comparison to patients without such pulmonary diseases.²⁸ One the patient is

intubated, the airway loses its sterility and gets infection within a few hours after starting the MV.²⁹ In these situations, there are several complications may occur. VAP is an important infectious complication found in the patients under MV which contributes to 8% to 28% of the patients admitted in the ICU.³⁰ The chances of the VAP are always present through the MV period. One study shows that the risk of the VAP is approximately 3% per day in the first week of the MV, 2% per day in the second week and 1% per day later.³¹ However, this period are very important for preventing the VAP. Each component from the ventilator to the lungs is important when considering the care of the patients during MV. The risk for VAP in intubated patients at ICU include age more than 60 years old, multiple intubations, changing the ventilator circuit and even the timing of the tracheostomy.^{32,33}

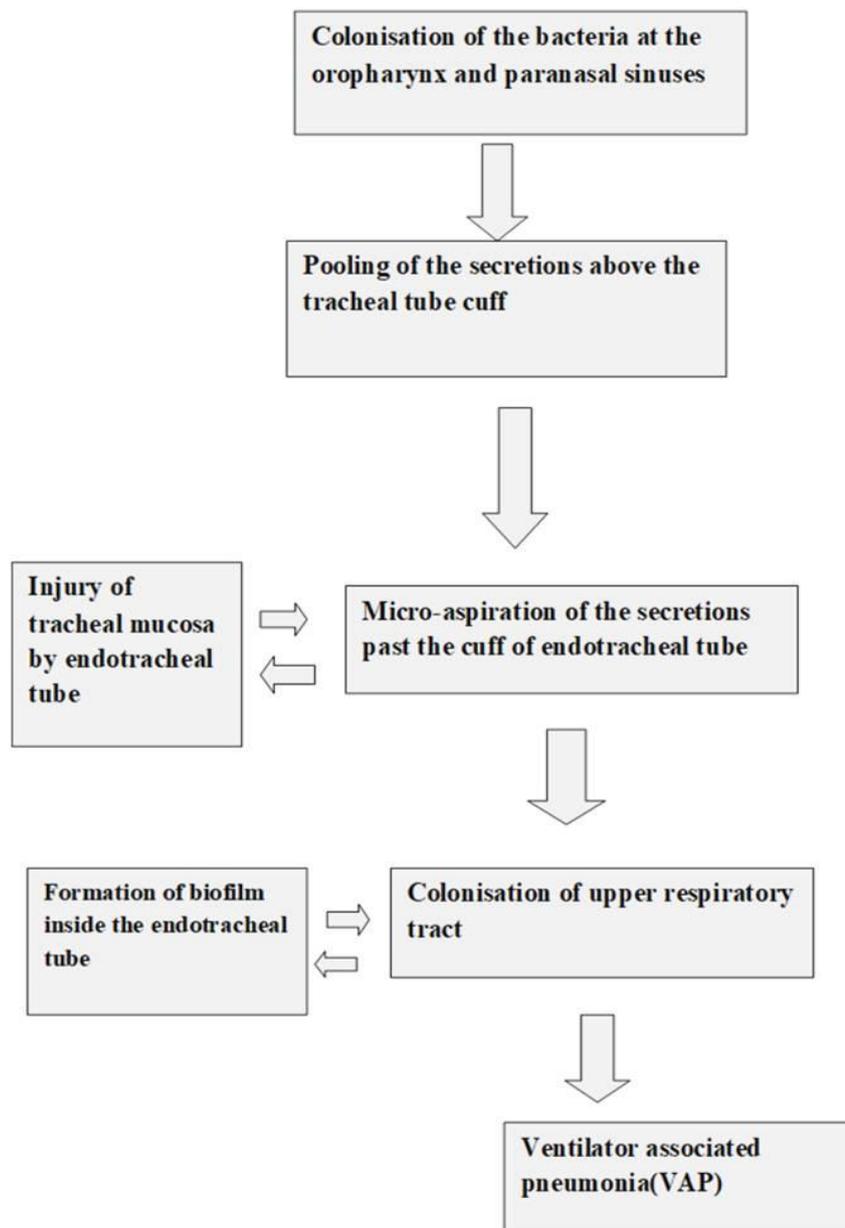


Figure 1: Pathogenesis of the VAP.

ROLE OF TRACHEOSTOMY

Tracheostomy is a surgical procedure which improves the respiratory mechanics and comfort of the patient which helps towards the secretions and weaning. The important benefits of the tracheostomy are reduced damage to the larynx, early weaning from mechanical ventilation, decreased stay in the ICU and enhanced patient comfort.³⁴ The potential complications of tracheostomy are infections, subglottic stenosis, loss of airway and even death of the patient.³⁴ Tracheostomy also reduces the risk for development of the VAP in comparison to the translaryngeal intubation. There is always ongoing debate on the risk and benefits for early tracheostomy on critically ill patients in the ICU. The early tracheostomy group is defined as patients those had seven or fewer days of continuous ventilation whereas the late tracheostomy group had more than seven days of continuous ventilation.³⁵ Early tracheostomy is associated with less ventilator associated pneumonia, less ICU stay and higher number of intubation in early group of tracheostomy. Tracheostomy also reduces the use of the sedation which also an important factor for preventing the VAP.³⁶

INTUBATION, EARLY TRACHEOSTOMY AND VAP

Repeated intubations are associated with high chance of VAP.³⁷ However, it does not happen in all cases of intubated patients in the ICU. However, early tracheostomy group had a higher average number of intubations and lower rate of VAP. It is not fully understood why the patients those underwent early tracheostomy had a higher number of intubations. It may be due to aggressive treatment done with early extubation trials and these successive failures tempted for doing tracheostomy. The late tracheostomy group could have been up of more severely sick patients whose were too swollen or had higher ventilator setting for considering either extubation or tracheostomy. In many retrospective studies, it is difficult to determine the severity of illness and its impact on the decision for multiple intubations. Tracheostomy when performed early in the course of mechanical ventilation may allow for rapid weaning from mechanical ventilation, which may affect the duration of mechanical ventilation. American college of chest physicians consensus conference recommended for performing tracheostomy after 3 to 7 days in patients with ventilator when expectations for prolonged intubation. There are several studies and meta-analysis have addressed for timing of the tracheostomy among ICU patients. There are few studies have revealed a benefit for performing early tracheostomy.^{38,39} One study was also not in favour for early tracheostomy.⁴⁰ In one prospective study of the timing of tracheostomy, the incidence of the VAP reduced when the tracheostomy was done within 48 hours of intubation in comparison to those done at 14 to 16 days.⁴¹ After placement of the tracheostomy tube enabled the patients to be shifted out of the ICU to a ventilator step-down unit. Mortality was not significantly

decreased in the early tracheostomy group in comparison to late tracheostomy.⁴¹ However, the mortality was not found to be significantly reduced in previous meta-analysis of the timing for tracheostomy at less than seven days.⁴²

PREVENTION OF THE VAP

There are few important measures are done to improve the quality of the patient care for preventing the VAP. There are several strategies like adequate antibiotic measures, bacterial decontamination of the oral-pharyngeal cavity, positioning of the head, early gastrostomy, hand disinfection, proper use microbiologic surveillance, monitoring and early removal of the invasive devices.⁴³ However, performing early tracheostomy is also considered as important measures to reduce the risk of development of the VAP in comparison to the translaryngeal intubation.⁴⁴ Early tracheostomy may help for rapid weaning from the mechanical ventilation, which reduce the duration of the mechanical ventilation. Performing early tracheostomy in ICU patients is usually associated with less chance of VAP, more frequent intubations, decreased total admission time and lower mortality rate.⁴⁵ The prevention of the VAP can be done interrupting these mechanisms like removal of the subglottic secretions, elevation of the bed head and use of the antimicrobial coated endotracheal tubes. Removal of oropharyngeal secretions which have pooled above the tracheal tube cuff through subglottic secretion drainage further decreases the micro-aspiration. There are specially designed tracheal tubes available with separate lumen or lumens which open above the cuff and allow continuous or intermittent drainage of the pooled secretions. One meta-analysis showed that the subglottic secretion drainage results in 50% reduction of incidence of pneumonia.⁴⁶ This effect is more pronounced in patients those intubated for more than 72 hours and for early onset VAP. Microbial biofilm are often found on the luminal surface of the endotracheal tube in ventilated patients in ICU. Endotracheal tubes coated with antimicrobial silver hydrogel showed delayed and decreased bacterial colonisation in mechanically ventilated patient.¹⁹

CONCLUSION

Patients requiring prolonged mechanical ventilation have significant reduction in the incidence of the VAP after performing the tracheostomy. Early tracheostomy provides important benefits in comparison to continued translaryngeal intubation including improved patients comfort, less requirement of sedation, easier weaning and potentially less time spent for mechanical ventilation and in the ICU. Early tracheostomy is independently associated with lower rate of VAP. Performing early tracheostomy is associated with less chance of VAP and mortality at ICU. It also reduces the duration of mechanical ventilation and the ICU stay of the patient in comparison to the patient with late tracheostomy.

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