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Comparative Evaluation of the Incidence of Ventilator Associated Pneumonia in Intermittent Oral Suction Vs Continuous Subglottic Suction in Adult Neurosurgical Patient Requiring Mechanical Ventilation: A Randomized Control Trial

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Abstract

Introduction: Ventilator Associated Pneumonia (VAP) is the most common nosocomial infection in intensive care units (ICUs). The impaired host defenses and continuous exposure of the lower respiratory tract to large number of pathogens through the endotracheal tube makes the mechanically ventilated patient prone to developing VAP. Thus present study was planned to compare the incidence of VAP in neurosurgical patients with continuous subglottic suction and conventional intermittent oral suction. *Material and methods:* A total of 70 adult neurosurgical patients who were expected to require mechanical ventilation for more than 72 hours were enrolled in this prospective study. These patients were randomized into two groups of 35 each. In group 1 patient were intubated with the conventional endotracheal tube and intermittent oral suction was done every 4 hourly and as and when required in addition. In group 2 the patients were intubated with Evac tube and continuous suctioning was done by maintaining a negative pressure of 20-25 mm Hg. Both the groups were compared for the incidence of VAP. *Results:* Both the groups were comparable with regard to age and sex distribution. The incidence of VAP was 17.1% in patients of control group and 11.4% in patients of study group. There was an overall reduction in the incidence of VAP by 5.7% by the use of continuous subglottic suction the reduction. *Conclusion:* As the result shows 5.7% better outcome in study group as compared to control group, therefore the intervention used in the study group i.e. continuous subglottic suction is better than that used in control group i.e. intermittent oral suction.

Keywords: Ventilator Associated Pneumonia; Continuous Subglottic Suction; Hi-Lo Evac Tube.

Introduction

Ventilator Associated Pneumonia (VAP) is defined as pneumonia occurring in patients who have been intubated and ventilated mechanically for more than 48 hours [1]. Ventilator Associated Pneumonia (VAP) is the most common nosocomial infection in intensive care units (ICUs) [2]. Ventilator Associated Pneumonia accounts for up to 25% of all ICU infections [3]. However, the incidence of VAP varies considerably depending on the definition used for diagnosis and the patient population being studied.

In the mechanically ventilated patient, a number of factors interact to compromise host defenses such as immune system is impaired by critical illness, co morbidities [4] and malnutrition [5]. Endotracheal intubation may thwarts the cough reflex [6], compromise mucociliary clearance [7], injure the tracheal epithelial surface [8], and provides a direct conduit for rapid access of bacteria from above into the lower respiratory tract [9,10]. Invasive devices, ICU procedures and antimicrobial therapy create a favorable milieu for antimicrobial-resistant nosocomial pathogens to colonize the aero digestive tract [11]. This combination of impaired host defenses and continuous exposure of the lower

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respiratory tract to large number of potential pathogens through the endotracheal tube makes the mechanically ventilated patient prone to developing VAP. Mechanically ventilated neuro intensive care patients are at an increased risk for VAP due to factors such as decreased level of consciousness and inability to protect the airway [12,13].

VAP is a clinical diagnosis. There is no single clinical manifestation that can be used to diagnose VAP. Although chest radiograph is very sensitive yet it is typically nonspecific [14].

Other clinical signs (fever, leukocytosis or pulmonary manifestations) have intermediate predictive values [14-16]. The clinical diagnosis of VAP is made by the association of a new or progressive infiltration on chest radiograph plus at least two of the following variables: fever or hypothermia, leukocytosis or leucopoenia and purulent secretions. These criteria were proposed by Johanson et al [17]. Despite this relatively low accuracy, these criteria were recommended by the American Thoracic Society Consensus Conference on VAP.

Prevention of VAP has focused primarily on elevating the head end of bed, thromboembolism prophylaxis, stress ulcer prophylaxis, daily sedative interruption and daily assessment of patient's readiness to be weaned from mechanical ventilation.

Endotracheal tube used during mechanical ventilation prevents glottic closure. As a result the patient is unable to cough out and remove secretions. Pooling of oropharyngeal secretions occurs above the endotracheal tube cuff which can be silently aspirated along the cuff.

Specialized endotracheal tube equipped with a suction port immediately above the cuff, known as Hi-Lo Eva tube is thought to mitigate the risk of aspiration around the cuff by permitting intermittent or continuous aspiration of subglottic secretion pooling around the cuff [18]. This can reduce the volume of fluid aspirated into the lungs.

Thus present study was planned to compare the incidence of VAP in neurosurgical patients with continuous subglottic suction and conventional intermittent oral suction. It was hypothesized that by using continuous subglottic suction one can decrease the pooling of secretions in the space between the laryngeal aperture and the endotracheal tube cuff, and hence can prevent or minimize micro aspiration, tracheal colonization with bacteria, and ultimately VAP.

Material and Methods

This prospective, randomized and comparative trial was conducted at the intensive care unit of our hospital after taking approval from the ethical committee. The study protocol was explained and written informed consent was taken from the relative of the patient. The 70 neurosurgical patients were included in the study. Inclusion criteria were age between 18 and 60 years, patients requiring mechanical ventilation for more than 72 hours having normal hemodynamic and normal ABG values.

The patients having ARDS, underlying COPD, active chest infection, were in shock requiring one or more inotrope or already been ventilated for more than 24 hours were excluded from the study. The patients were then randomized into two equal groups of 35 each using computer generated table of random numbers.

In group 1 patient were intubated with the conventional endotracheal tube (Figure 1) and intermittent oral suction was done every 4 hourly and as and when required in addition.

In group 2 the patients were intubated with Evac tube (Figure 2) and continuous suctioning was done by maintaining a negative pressure of 20-25 mm Hg.

The pressure of cuff of the ETT was kept in the range of 25-30 cm H_2O to maintain an adequate seal. In both the groups closed endotracheal suction catheter system (Figure 3) was used for suctioning.

Other parameters for the prevention of VAP were confounded in all patients that included 45 degrees anti trendelenberg position, oral decontamination with Listerine, injection pantoprazole for aspiration prophylaxis and HME filter in ventilator circuit. The interruption of sedation was done daily to check for weaning.

The disposable ventilator circuit tubing used throughout in both the groups were similar and the empirical antibiotics i.e. Inj. Piperacillin, Tazobactam and Amikacin were started in both the groups were similar and as per ICU protocols. The double catheter technique or tube within tube technique was used for taking samples for tracheal culture.

Clinical parameters recorded were 4 hourly monitoring of temperature, heart rate and blood pressure. The investigations which were done are total and differential leukocyte counts on the day of admission in ICU and every day till 7 days. The ETT culture was sent on the day of admission and

every alternate morning till 7 days. The blood culture was sent on the day 3 and 6 of ICU stay. The chest radiograph was done on day 1 and every alternate day till 7 days which was interpreted by a radiologist blinded to the group assignment.

VAP was considered to be present if

1. Chest radiograph showed new or progressive diffuse infiltrates which was not attributable to any other cause
2. Plus any two of the following

- Fever or hypothermia- temperature more than 37.5^0 C or less than 33.5^0C
- Leucocytosis or leucopenia- WBC more than 11000/mm^3 or less than 4000mm^3
- Positive tracheal culture

The patients who were weaned from the mechanical ventilation before 7 days and who expired during the course of the study were labeled as failures and were eliminated from the study.

Results

A total of 70 adult patients were enrolled in the study and randomized in 2 groups of 35 each. In both the groups sex distribution was the same with males comprising about 68.6% of the study population (24 males out of 35 patients). The age wise distribution of the patients in both the groups was almost comparable with the majority of patients being in the 21-40 yrs of age (Fig. 4). Trends of temperature, total leucocyte counts, tracheal cultures, chest x- rays and diagnosis of VAP is shown in table 1. The incidence of VAP is 17.1% in patients of control group (Group I) and 11.4% in patients of study group (Group II) (table 1). Although there was an overall reduction in the incidence of VAP by 5.7% by the use of continuous subglottic suction the reduction was not statistically significant. Only one patient showed a positive blood culture, showing that blood culture is not a useful predictor for diagnosing ventilator associated pneumonia. Out of the 10 patients who had developed VAP, 7 patients were positive for all the four factors used for diagnosing VAP. The remaining 3 patients developed radiographic infiltrates in addition to 2 out of the 3 factors i.e. fever or hypothermia, leucocytosis or leucopenia and positive tracheal culture.

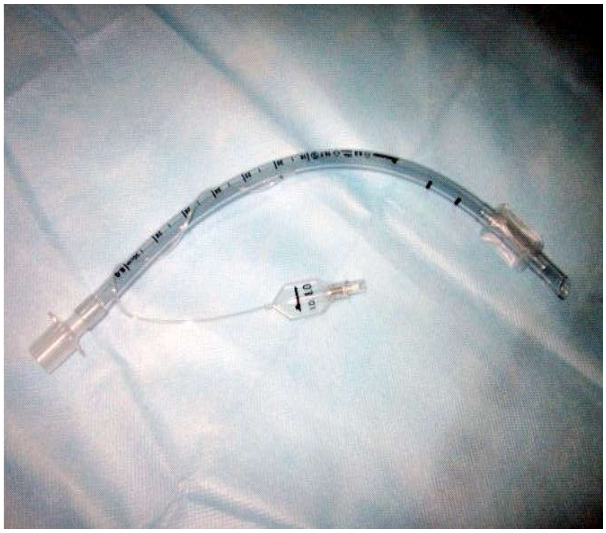

Fig. 1: Conventional Endotracheal tube used in patients of group I

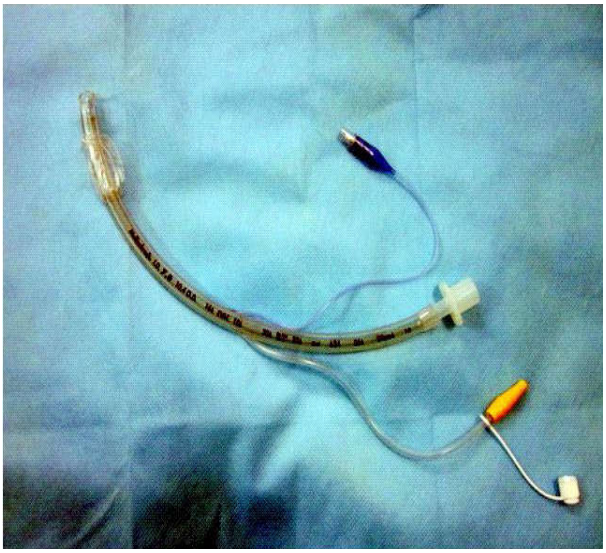

Fig. 2: HI- LO EVAC tube with an additional port for subglottic suction used in patients of group II

Table 1: Showing comparison of two groups in different parameters, *- p value >0.5 ; not significant

Parameters	Group I (n=33)	Group II (n=34)	Chi Square	DF	P value
Fever/ Hypothermia	7	4	1.0892	1	0.3*
Leukocytosis/ Leukopenia	7	4	1.0892	1	0.3*
Positive tracheal cultures	5	3	0.986	2	0.611*
Positive CXR	6	4	0.891	2	0.640*
Diagonosed as VAP	6	4	0.54	1	0.46*

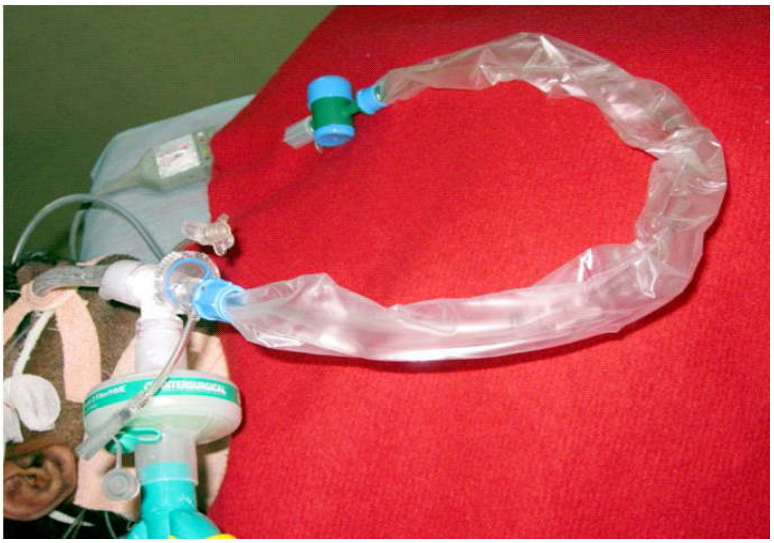

Fig. 3: Closed suction system and HME filter in place

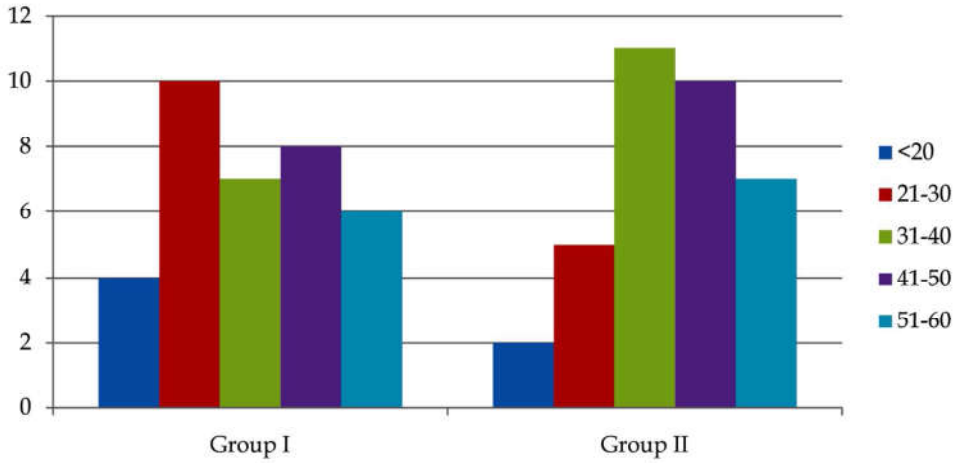

Fig. 4: Age distribution, χ^2=3.52, df-4, p=0.47

Discussion

Ventilator Associated Pneumonia (VAP) is the most common nosocomial infection in intensive care units (ICUs) [2]. There is a direct relationship between the colonization of gastric, oropharyngeal and tracheobronchial secretions in the pathogenesis of ventilator associated pneumonia. The subglottic space is a key position in which oropharyngeal and gastric secretions accumulate at the deepest point. These secretions are not removed by usual suction methods of the pharynx and the trachea.

This randomized controlled trial evaluates the efficacy of subglottic suction as a measure to reduce the incidence of ventilator associated pneumonia.

In our study 70 adult neurosurgical patients with an expected duration of mechanical ventilation >72 hours were randomized into two groups with 35 patients each in Group I and Group II. Out of the 70 patients, 2 patients were extubated and 1 patient expired during the course of study constituting the failure cases. Out of these, 2 patients belonged to the control group and 1 patient to the study group. VAP developed in 10 patients out of which 4 patients belonged to subglottic suction group and 6 patients belonged to intermittent oral suction group. The incidence of VAP in patients of control group is 17.1% and the incidence of VAP in patients of study group is 11.4% (table 1). Diagnosis of VAP was made based on various clinical and laboratory parameters including radiographs up to a period of 7 days.

Several criteria have been proposed for diagnosing VAP including clinical criteria, imaging techniques, microbiological criteria and biomarkers of host response. The criteria used in our study to diagnose VAP were similar to those proposed by Johanson et al [17]. The values of sensitivity and specificity were 69% and 75% respectively (accuracy

of 72%). Despite this relatively low accuracy, these criteria were recommended by the American Thoracic Society Consensus Conference on VAP.

The incidence of VAP was 17.1% in patients of control group and 11.4% inpatients of study group (table 1). On applying chi square test using a 2x2 contingency table and the degree of freedom being 1, the value of chi square was 0.47 with a p value of 0.49 with the failure cases being included in the study.

If the failure cases were excluded from the analysis and chi square test applied, the value of chi square was 0.54 and p value was 0.46 with the degree of freedom being 1.

In both the scenarios the results were statistically non significant. When fisher-1 tailed test was applied the p value was 0.347 which was still non significant but more significant as compared to chi square test.

Valles et al [19] in 1995 performed a randomized study in 190 patients who were likely to be ventilated for more than 3 days. They found a relative reduction of 43% in ventilator-associated-pneumonia (VAP) by using continuous sublottic suction with an incidence of 18.4% in the study group and 32.5% in the control group.

Smulders et al [20] in 2002 performed a randomized controlled trial in 150 general ICU patients with predicted ventilation of over 3 days. They used subglottic suction, but instituted intermittent suction with 8 seconds of suction every 20 seconds. They found a significantly reduced incidence of pneumonia in the suction group, reducing the incidence of VAP from 16% to 4%.

Mahul [18] performed a randomized trial in 145 patients with a predicted intubation time of over 3 days. A significant reduction in nosocomial pneumonia was found with hourly subglottic suction. 29% of controls suffered pneumonia compared to only 13% in the suction group.

Kollef et al [21] performed a study in patients of post cardiac surgery. 343 patients undergoing cardiac surgery and requiring mechanical ventilation in the cardiothoracic ICU were randomized to either continuous subglottic suction or normal ET-tube. They found a non-significant reduction of VAP from 8.2% in controls to 5% in the subglottic suction group. However they found a significant delay in the onset of VAP, with a mean time of 2.9 days in the control group compared to 5.6 days in the subglottic suction group. In a review performed by Collard [22], the evidence was mixed and was graded as IIa. Continuous suction did not convincingly reduce VAP. However. It was stated that this intervention may be considered in all patients who may require more than 3 days of ventilation.

In a systematic review performed by Dodek et al [23] in 2004 for the Canadian Critical Care trials Group, it was recommended that clinicians should consider the use of subglottic secretion drainage in all their patients. In a recently published systematic review and meta analysis by Muscedere et al [24] of endotracheal tubes with subglottic secretion drainage there was a highly reduction of VAP by approximately 50% which was highly significant in mechanically ventilated patients who received this intervention. They included 13 RCTs with more than 2400 randomized patients.

A meta analysis published in 2005 by Dezfulian et al [25] evaluated 896 patients concluded that there is a benefit of continuous aspiration of subglottic secretions to reduce Ventilator Associated Pneumonia despite the diversity of research variables among the continuous aspiration of subglottic secretion trials. In patients with some form of aspiration of subglottic secretions the VAP risk reduction was 50%, primarily through reduction of pneumonia within first 5 to 7 days of intubation [26].

The most probable cause for the non significant result of our study was the small sample size. It constituted major limitation of our study. The small sample size of 70 was chosen based on an audit conducted in our multidisciplinary ICU which showed that the number of neurosurgical patients admitted in the ICU who had a period of mechanical ventilation of more than 3 days were around 20 over a 3 months duration. As the total duration of study was 15 months, a sample size of 70 was chosen.

Although not statistically significant yet the overall rate of VAP was less among the patients receiving continuous subglottic suction. Therefore further studies involving a larger sample should be done to establish this fact emphatically.

Conclusion

Our study showed 5.7% better outcome in study group as compared to control group, therefore the intervention used in the study group i.e. continuous subglottic suction is better than that used in control group i.e. intermittent oral suction.

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