

Evaluation of the Effect of Open and Closed Tracheal Suction on the Incidence of Ventilator Associated Pneumonia in Patients Admitted in the Intensive Care Unit

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Background: Nosocomial pneumonia is a prevalent complication in patients admitted to intensive care units (ICU). Endotracheal suction is used in cleaning the airways of secretions in patients under mechanical ventilation. Performing suction accurately is of great importance to prevent ventilation associated pneumonia. The purpose of this study was to compare the effect of open versus closed tracheal suction on the incidence of VAP.

Methods: This was a clinical trial study performed on 86 intubated patients in ICU. Patients of control group (n=43) underwent conventional open suction and case group (n=43) closed suction. After 72 hours, patients were assessed regarding VAP using clinical pulmonary infection score (CPIS).

Results: There was no significant difference regarding age (p=0.15) and gender (p=0.33) between the two groups. The incidence of ventilator associated pneumonia was significantly lower in closed method compared to the open method (p=0.016).

Conclusion: Closed tracheal suction compared to the open method was associated with lower incidence of VAP in patients of ICU.

Keywords: ventilation associated pneumonia; intensive care unit; nosocomial pneumonia

Nosocomial pneumonia is a prevalent complication in patients admitted to intensive care units [1-5]. Patients under mechanical ventilation are at greater risk of nosocomial pneumonia [2-6]. Ventilator associated pneumonia (VAP) is a kind of nosocomial pneumonia that occurs in patients who underwent mechanical ventilation through the tracheal tube or tracheostomy. The incidence of pneumonia in intubated patients and those under mechanical ventilation is ten times more than those with spontaneous respiration without ventilation instruments. VAP increases the duration of mechanical intubation by 7.6 days and ICU stay by 11.5 days [7-9]. Many cases of VAP are due to disconnection of mechanical ventilation system, which is

preventable [10]. Mortality rate due to VAP in ICU has been reported by 24% to 76% in different investigations [11-12].

VAP associated expenses in diagnosis and treatment of ICU patients are significant. VAP is associated with poor prognosis and increased duration of hospitalization and ventilation [13]. Presence of tracheal tube increases the chance of VAP, because it decreases natural defense mechanisms of patients' airways. For instance, diminished coughing reflex allows microorganisms to access lower respiratory tracts [1,13-14]. Persistent inhalation of small oropharyngeal (subglottic) droplets is the main mechanism of VAP. However, early pneumonia occurs usually due to microaspiration of nasopharynx bacterial colonies, but there is a weak association between late pneumonia and microaspiration [3]. To reduce persistent aspirations of discharges by the tracheal tube cuff in intubated patients, it is suggested to use intermittent or continuous suction of oropharyngeal discharges [1-2,10].

As mentioned above, one of the methods to decrease the incidence of VAP is tracheal suction, which is performed broadly in patients under mechanical ventilation. This prevents blockage of airways by secretions and provides sufficient oxygenation [1,10,15-16]. Investigations showed that one of the most important ways of infection transmission is suction of airways discharges through used instruments, contaminated hands and air of these wads [17-19].

The most common type of suction is open suction, in which the patient should be disconnected from the ventilator; therefore, patient is compromised from oxygen, moisture and positive end expiratory pressure during

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suction, therefore, unstable patients may become hypoxic during open suction. Another method is the closed one, in which patient is not disconnected from the ventilator during suctioning [13,16,20-21].

Ebrahimi Fakhari et al. evaluated the effect of tracheal closed suction on VAP on 156 patients and they followed patients after 72 hours regarding pneumonia and showed that closed suction is associated with less risk of VAP compared to open suction [21]. The main question is that whether closed suction can reduce the risk of VAP and its related morbidity and mortality as different studies yielded controversial results on this issue. Therefore the aim of this study was to compare the effect of open versus closed tracheal suction on the incidence of ventilation associated pneumonia (VAP).

Methods

This was a randomized clinical trial on 86 intubated patients under mechanical ventilation admitted to intensive care unit. Inclusion criteria were patients who needed endotracheal tube with positive pressure mechanical ventilation, aged 15 to 80 years, duration of hospital admission to ICU hospitalization less than 4 hours, no history of smoking, semi-setting position in ICU, level of consciousness below 9, not having much discharges and not needing more than 2 times suction in each working shift, spontaneous or SIMV (synchronized intermittent mandatory ventilation) mode of ventilation, not using antibiotics except routine medications of the ward (cephazolin), having nasogastric tube and not having pneumonia or any other underlying respiratory diseases that increase the incidence of pneumonia. Exclusion criteria were intubation less than 72 hours, patients dying before 72 hours, receiving cardiac medications during the study and need for more than 2 times of suction in each working shift. This study was performed after approval from the ethics committee of Hamadan University of medical sciences. A written consent was obtained from legal guardians of patients. Patients who met the inclusion criteria were divided randomly into case and control groups using random blocks with four blocks. Before sampling, instruments needed for open and closed suction were prepared and all ICU nurses were educated how to use them properly based on standard protocol of suction. Data were recorded in special forms including demographic characteristics, date and time of intubation, date and time of hospitalization, date and time of ICU admission, date of acquiring VAP (if occurred) collected by trained researcher. In patients who underwent open suction, our nurse suctioned secretions using sterile gloves and catheter changed after each suction. First, tracheal tube was disconnected from the ventilator and discharges suctioned by inserting a catheter into tracheal tube. After suction, patient was reconnected to ventilator and ventilated during 2 minutes by 3 to 5 inhalations with oxygen 100% using ventilator.

In closed suction group, one end of closed suction catheter was connected to ventilator and tracheal tube and the other end to suction tube. After opening the catheter valve, a relaton catheter was inserted into the tracheal tube and secretions were suctioned (without disconnecting patient from the ventilator). In both groups, in each time of tracheal suction, suction was performed 1-3 times and the time of suction was 5-10 seconds in the both methods. To assess pneumonia, bacterial pneumonia index was used. Patients were monitored for 72 hours from admission and examined by an infection disease specialist. Bacterial pneumonia index is a standard index calculated based on body temperature, white blood cell count, airways discharges, ratio of arterial blood oxygen to inhaled oxygen, auscultation regarding infiltration development, chest X-ray, culture and smear of lung discharges (Table 1). Patient was considered to have pneumonia if scored more than 6.

For analyzing data, SPSS version 18 (SPSS Inc., IMB Corporation, Chicago, Illinois, USA) was used. Chi-square test and independent T test were used to compare demographic data. Chi-square was also used to compare ventilator associated pneumonia between the two groups.

Results

In total, 102 patients were included; 5 were excluded due to poor cooperation of personnel, 6 due to mortality before 72 hours and 5 due to increased discharges. Finally, data of 86 patients were analyzed. Reason of admission for these patients in intensive care unit in closed suction group were trauma 23 patients (53.5%), CVA 10 cases (23.3%), brain tumor 5 cases (11.6%), brain abscess 3 cases (7%) and brain hemorrhage 1 case (2.3%). In open suction group included trauma 20 patients (46.5%), CVA 14 cases (32.6%), brain tumor 3 cases (7%), brain abscess one case (2.3%), brain hemorrhage 2 cases (4.7%) and bowel obstruction 3 cases (7%). There was no significant difference regarding the reason of admission between the two groups using Fisher exact test ($P=0.59$). The mean age of patients in open suction group was 58.2 ± 18.5 years and in closed suction group 52.4 ± 18.6 years; there was no significant difference between the two groups ($P=0.15$). In closed suction group, 29 were male (67.4%) and 14 female (32.6%). Open suction group, there were 33 male patients (76.7%) and 10 female (23.3%). There was no significant difference regarding gender between the two groups using Chi-square test ($p=0.33$).

The incidence of ventilator associated pneumonia was compared between the two groups of open and closed suction groups. As demonstrated, 17 (39.5%) patients in open suction group developed VAP; however, in the closed suction group, only 7 cases (16.3%) had VAP; the difference was significant regarding the incidence of ventilator associated pneumonia ($P=0.016$). The incidence of ventilator associated pneumonia was significantly less in closed suction group compared to the open group (Table 1).

Table 1- Comparing relative and absolute distribution frequency of ventilator associated pneumonia (VAP) in patients under open and closed suction in ICU

Ventilator Associated Pneumonia		Yes Number (%)	No Number (%)	Total Number (%)	P value
Study Groups	Open Suction	17 (39.5%)	26 (60.5%)	43 (100%)	0.016
	Closed Suction	7 (16.3%)	36 (83.7%)	43 (100%)	

* Using Chi-square test

** Below 0.05 as meaningfully significant

Discussion

Our results showed that closed suction reduced the incidence of VAP in patients admitted to ICU. Different studies in this regard showed controversial findings. In a prospective clinical trial performed by David et al. expenses and clinical results of open and closed suction were assessed in 200 patients under mechanical ventilation in India; they found that closed suction is associated with some benefits for patients such as reducing the incidence of VAP, especially its delayed type. However, mortality rate and hospital stay in ICU were the same in both groups, while expenses were higher in closed suction group [22]. In our study, early or delayed type of VAP, mortality rate and hospital stay in ICU were not considered, which is suggested to be further assessed by upcoming investigations.

Ebrahimi Fakhar et al. assessed the effect of closed suction of airways discharges on the incidence of VAP on 156 patients after 72 hours and concluded that closed suction is associated with lower risk of ventilator associated pneumonia compared to open method [21]. The reasons of less incidence of VAP in closed suction group might be less transmission of pathogens through used instruments, unclean hands of nurses and contaminated air of these wards [18-19,23]. Branson in a review article indicated that as much less the ventilator connections are detached, the less the risk of infection would be, which obviously supports the closed suction method [24]. Combes et al. assessed nosocomial pneumonia in patients under mechanical ventilation (a randomized prospective trial of closed suction) and concluded that closed suction reduced the risk of VAP without any significant adverse effect [25].

However, among studies assessing open and closed suction on the incidence of VAP in ICU, some studies showed that closed suction method has no superiority over open method in reducing the incidence of VAP, which is not consistent with the present investigation. Below are some of these studies. In a systematic review by Subirana et al. 16 clinical trials were assessed; their results showed that open or closed suction method had no effect on VAP [7]. In a non-randomized case control prospective study entitled by Morrow et al. on 259 patients admitted to children hospital, closed suction method was found to have no effect on the frequency of ventilator associated pneumonia or disease outcome [26]. Furthermore, Nie'l-Weise et al. in a systematic review of 10 randomized clinical trials concluded that closed suction has no superiority over open suction to decrease VAP and suggested to provide more comprehensive explanations about the end of the study protocol and frequency of suctioning in further investigations [27]. Performed investigations yielded different results regarding the effectiveness of closed suction on ventilator associated pneumonia; some of them agreed and others disagreed with the current study. Controversial results might be due to low number of patients under study, not educating the principles of using closed suction to nurses and consequently misuse of closed suction, not appropriate inclusion or exclusion criteria such as including patients with underlying respiratory diseases or excessive discharges or not excluding those patients who have excessive discharge during the study due to any reason or short duration of study period. However, in the present study it was tried to solve the above mentioned shortages as far as possible by proper training for using closed suction to

nurses, considering appropriate inclusion and exclusion criteria; for instance, excluding patients with underlying respiratory diseases or having excessive discharge. Therefore, considering benefits of closed suction compared with open suction including preserving ventilation with positive pressure during suction, less fall in arterial oxygen, decreased complications such as hypoxia or atelectasis, decreased risk of spreading contaminated bronchial discharges and microorganisms access to airways [15,17,19,28], using closed suction is suggested to reduce the incidence of ventilator associated pneumonia. Besides, further investigations are recommended to compare ICU stay and expenses of suction in closed and open methods.

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