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The Effect Of Silver-Coated Endotracheal Tube On The Incidence Of Ventilator-Induced Pneumonia In Intubated Patients Admitted To The Intensive Care Unit (ICU)

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ABSTRACT

Background and Aim: Ventilator-associated pneumonia (VAP) is one of the main problems of intubated patients in the intensive care unit. the antibacterial endotracheal tube ara capable of reducing VAP via stopping bacterial colonization and biofilm formation. Therefore, in this study, the effects of silver-coated endotracheal tube on the incidence of VAP were investigated.

Materials and Methods: In a single-blind clinical trial study, 108 patients in need of intubation were selected and divided into two intervention groups (antibacterial endotracheal tube) and control (standard non-coated endotracheal tube). Demographic information, secretion volume and shape, leukocytosis, decreased oxygen saturation, fever were recorded for all patients and compared in the two intervention groups.

Results: The mean age (±SEM) in the intervention and control groups was 42.93 (±1.42) and 47.86 (±2.08) years, respectively. ♂Furthermore, the incidence of VAP in the intervention and control groups was 5 (±1.8) and 8.5 (±2.1) days, respectively. Patients receiving a antibacterial endotracheal tube had a significantly reduction in the volume of secretions (P = 0.0027), incidence of purulent secretions (P = 0.04), fever (P = 0.019), leukocytosis (P = 0.0006), culture positive (P = 0.0001), and the onset of VAP symptoms (P = 0.001). The incidence of VAP in the intervention and control groups was 18% and 26%, respectively, and the antibacterial endotracheal tube significantly reduced the incidence of VAP (P = 0.0003).

Conclusion: Silver-coated endotracheal tube?? has a more effective role in improving the prognosis of intubated patients admitted to the ICU when comparing with standard non-coated endotracheal tube.

Keywords: Ventilator-induced pneumonia, endotracheal tube.

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INTRODUCTION

Pneumonia is an inflammatory infection of the air sacs in one or both lungs that causes the air sacs to become full of fluid, with side effects such as cough with sputum, fever and chills, and respiratory distress. Various organisms, including bacteria, viruses, and fungi, can cause pneumonia (1). Some people develop pneumonia after being hospitalized for another illness. And this type of pneumonia can have very serious complications due to antibiotic resistance and an underlying disease. Pneumonia is more prevalent among people using ventilators in the intensive care unit (2).

Ventilator-associated pneumonia (VAP) is a type of nosocomial pneumonia that occurs in patients who are mechanically ventilated (3). VAP usually develops within 48 to 72 hours after the mechanical ventilation. The main purpose of mechanical ventilation is to help exchange gas without damaging the lungs. Unfortunately, mechanical ventilation can damage the lungs through repetitive stretching of lung tissue and pressure.According to the International Nosocomial Infection Control Consortium (INICC), the overall incidence of VAP is 13.6 per 1,000 ventilator days (4). This incidence varies according to the group of patients and the condition of the hospital and varies from 13–51 per 1,000 ventilator days (5). The average duration of VAP is about 5 to 7 days, and the mortality rate associated with this condition is reported to be about 24 to 76%, which is higher in critically ill patients (6).

Ventilator-associated pneumonia directly increases the length of stay in the intensive care unit (ICU) and indirectly increases patients' treatment costs. Based on the time of onset of VAP, this condition is divided into two types. The first type, called Early-onset VAP, occurs within the first 4 days of mechanical ventilation and is usually caused by antibiotic-sensitive bacteria. And the second type, called late onset VAP, which occurs after the fifth day of mechanical ventilation and is caused by pathogens resistant to several drugs (7, 8). Early detection of VAP and appropriate antibiotic treatmentcould be capable of reducing the emergence of resistant organisms.Medical devices are rapidly colonized by bacteria during biofilm formation, which in turn can cause infections associated with medical care (9, 10). However, since the use of these equipments and devices is very necessary in the treatment of patients, it is not possible to not use these equipments and this issue is very important in order to reduce their complications by conducting extensive studies. To reduce the formation of biofilm in endotracheal tubes, placing pure silver compounds on these tubes its effectiveness has been evaluated in various studies. These studies have reported that silver compounds are capable of reducing biofilm formation and delaying the development of VAP in patients (11, 12). Metal alloy-coated latex has been

widely used in urinary catheters (13, 14). In another study conducted in 2012 by Li X et al., the use of silver-coated endotracheal tube was associated with a lower incidence of VAP and other ventilator-related complications, while there is very little evidence for this and it should be repeated in more centers (15). Regarding the complications and costs of the VAP incidence, but there was no difference in mortality. However, in this review study, VAP also occurred in patients admitted to the ICU. According to the characteristics of antibacterial endotracheal tube, the current study aimed to evaluate the effect of Bactiguard's endotracheal tubes on the incidence of VAP in intubated patients admitted to the ICU. Bactiguard's endotracheal tube is made by Swedish Bactiguard company. The outer surface of this tube is covered by noble metal alloy coating, gold, and palladium, which prevents the formation of colonized biofilm by reducing the adhesion of bacteria and secondary respiratory infections. If it be found that the complications of the Bactiguard endotracheal tube are less than endotracheal tube, antibacterial endotracheal tube can be used for patients who need endotracheal placement.

MATERIALS AND METHODS

This single-blind clinical trial study was performed on 108 intubated patients admitted to the intensive care unit of Valiasr Hospital in Arak, Iran. The code of ethics was taken from the ethics committee of Arak University of Medical Sciences and then the intervention was performed after recording a clinical trial. All samples were matched as much as possible in terms of age, sex and type of disease. BIP endotracheal tube and uncoated endotracheal tube were used for the intervention and control groups, respectively. Inclusion criteria were: age 18 to 60 years, GCS ≤10, no history of lung disease and LOC, no pulmonary involvement (pulmonary contusion, pneumothorax, aspiration of Hemothorax). Patients who developed pulmonary involvement, positive culture, or death during the study were excluded from the study. At the beginning of the study, culture and CXR were prepared for the patients. Patients were not included in the study if there was any infection or pulmonary involvement. For all patients, demographic information, secretion volume change, deformation, leukocytosis, decrease in oxygen saturation, fever, number of days under ventilator, culture and CXR involvement were recorded in the prepared checklist. Finally, the obtained data were analyzed using Graph Pad software. It should be noted that written consent was obtained for all patients to participate in the study with the patient from the University Ethics Committee. The patient was also assured that participation or non-participation in the study has no effect on the patient treatment process and all patient information will remain confidential.

RESULTS

The results of this study showed that the mean age (±SEM) in the intervention and control groups was 42.93 (± 1.42) and 47.86 (± 2.08) years, respectively. Also, the minimum and maximum age of patients in the intervention and control groups were 10-60 and 20-63 years, respectively. Independent sample T test showed that there was no statistically significant difference between the two groups in terms of age (P = 0.05). In other words, the two groups were the same in terms of age. Based on the results presented herein, 42 individuals (73.68%) were male in the control group and 47 people (82.45%) in the intervention group. Square Chi test showed that there was no statistically significant difference between the two groups in terms of gender (P = 0.36).

The results obtained by comparing the volume of secretion in the two groups showed that 22 patients (equivalent to 39%) did not have secretion in the control group, followed by low secration (29 patients, 50.46%), moderate secretion (3 patients, 5.27%) and high secretion (3 patients, 5.27%). Also, in the intervention group, 23 patients (41.35%) did not have secretion, followed by low secretion (32 patients, 56.14%), moderate secretion (2 patients, 3.12%) and high secretion (0 patients), (Table 1). Chi square test showed that there was a statistically significant difference between the two groups in terms of secretion volume (P = 0.027). In patients undergoing intubation with antibacterial tube, the volume of secretion was significantly lower than in patients undergoing uncoated tube intubation. In other words, the volume of secretions in patients undergoing intubation with antibacterial tube is less. Chi square test showed that purulent secretion in patients undergoing intubation with antibacterial tube was significantly lower than patients undergoing intubation with uncoated tube (P = 0.04, Table 1).

The prevalence of leukocytosis in the intervention and control groups was 40 (70.17%) and 29 (50.8%), respectively. Chi square test showed that there is a statistically significant difference between the two groups in terms of the frequency of leukocytosis (P = 0.0006, Figure 1). In other words, the incidence of leukocytosis in patients intubated with uncoated endotracheal tube was significantly higher than patients intubated with antibacterial tubes.

Figure 1: Comparison of the frequency of leukocytosis in the two groups

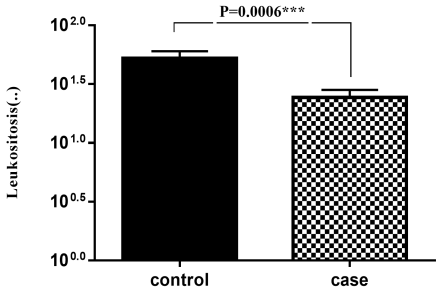


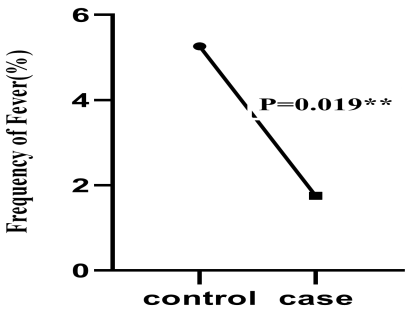
Table 1: Comparison of volume and type of secretions in two groups.

Patients	Volume of discharge (%)	Shape of discharge (%)
Intervention	Negative: 23(41.35%) Low: 32(56.14%) Moderate: 2(3.12%) Much: 0(0%)	Negative: 23(40.35%) Purulent: 2(3.50%) Watery: 32(56.15%) Traumatized: 0(0%)

Patients	Manifestation of VAP(day)	
Intervention	**Mean(±SEM):8.5(±2.1) Min-Max: 1.5-7**	
Control	**Mean(±SEM):5(±1.8) Min-Max: 2-9**	
P Value	**0.001****	
Control	Negative: 22(39%) Low: 29(50.46%) Moderate: 3(5.27%) Much: 3(5.27%)	Negative: 22(39%) Purulent: 9(15.30%) Watery: 24(42.20%) Traumatized: 2(3.50%)
P-value	0.027*	0.04*

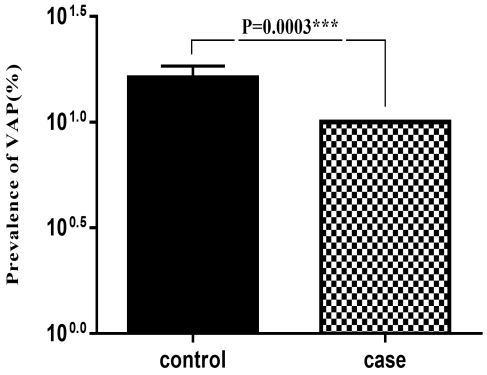
Statistically, there was no significant difference between the two groups in terms of o2 saturation reduction. Chi square test showed a statistically significant difference between the two groups in terms of fever (P = 0.019, Figure 2). In other words, the incidence of fever in patients undergoing intubation with a uncoated endotracheal tube is higher than patients undergoing intubation with an antibacterial endotracheal tube.

Figure 2. Frequency of fever in two groups



Our study showed that 4 (equivalent to 7.01%) and 7 patients (equivalent to 12.28%) had positive cultures in the intervention and control groups, respectively. Chi square statistical test showed that there is a statistically significant difference between the two groups in terms of frequency of positive culture (P <0.0001, Figure 3). In other words, the frequency of positive culture in patients intubated with uncoated endotracheal tube is significantly higher than patients intubated with antibacterial endotracheal tube.The statistical results obtained in this study showed that the prevalence of VAP

Figure 4. Comparison of VAP incidence in two groups



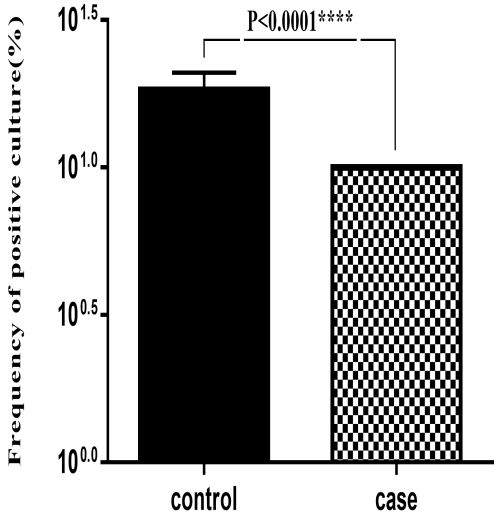


Figure 3. Frequency of positive culture in two grou

during 10 days of hospitalization in the intervention and control groups was 10 (17.54%) and 15 (26.13%), respectively.Chi square test showed that there is a statistically significant difference between the two groups in terms of the frequency of VAP (P = 0.0003, Figure 4). In other words, the incidence of VAP in patients intubated with uncoated endotracheal tube is significantly higher than patients intubated with antibacterial endotracheal tube.

The results showed that the mean (±SEM) days of VAP symptoms during 10 days of hospitalization in control and intervention groups were 5 (± 1.8) and 8.5 (±2.1) days, respectively.

Also, the lowest and highest day of VAP symptoms in the intervention and control groups were 1.5-7 and 5.2-9, respectively. Independent Sample T test showed a statistically significant difference between the two groups in terms of the onset time of VAP symptoms (P = 0.001, Table 2). In other words, the time of onset of VAP symptoms in patients undergoing intubation with a uncoated endotracheal tube was significantly earlier than in patients intubated with an antibacterial endotracheal tube.

Table 2. The mean time of onset of VAP symptoms in the two groups.

DISCUSSION

In this study, 108 intubated and ICU patients were evaluated to compare the effect of uncoated and antibacterial endotracheal tube on VAP. The mean age (±SEM) in the intervention and control groups was 42.93 (±1.42) and 47.86 (± 2.08) years, respectively. The mean day (±SEM) of VAP symptoms in the intervention and control groups was 8.5 (± 2.1) and 5 (± 1.8) days, respectively.This study showed that intubated patients with antibacterial endotracheal tube method had significantly less secretion and purulent discharge than intubated patients with uncoated endotracheal tube. Furthermore, intubation with antibacterial endotracheal tube significantly reduced the incidence of leukocytosis, fever and positive secretion culture; the rate of VAP in patients intubated with uncoated endotracheal tube was significantly higher than patients with antibacterial endotracheal tube intubation.In a study, Björling et al. (16) examined a BIP endotracheal tube and standard endotracheal tube for patient symptoms and local tracheal tolerability, the findings revealed that BIP endotracheal tube was well treated by patients and no mucosal damage was seen with bronchoscopy in BIP intubated patients and this tube has good clinical effects during short-term intubation. Our study, revealed that antibacterial endotracheal tub had good clinical performance, where significantly lower volume of secretions and purulent discharge were observed. Furthermore, the incidence of fever, leukocytosis and culture positive was lower as compared with uncoated endotracheal tube. The results of our study confirm the findings of Björling and both studies show a more useful and clinically effective role of antibacterial endotracheal tube than uncoated endotracheal tube. In other words, antibacterial endotracheal tube not only does not cause more complications, but also significantly reduces the volume of secretion, purulent discharge, fever, leukocytosis and positive culture of intubated patients, which shows the effectiveness of antibacterial endotracheal tube.In another study by Kollef et al. (1932), patients in need of intubation were divided into two groups: intubation with an uncoated endotracheal tube and a silver-coated endotracheal tube. And found that the incidence of VAP and delayed time to VAP occurrence in patients receiving silver-coated endotracheal tube was significantly lower as compared with those receiving uncoated tube. In addition, a significant difference was not found between the two groups in terms of intubation time, stay in ICU, mortality, and severity of complications. However, our study showed that the use of antibacterial endotracheal tube significantly reduced the volume of secretion, purulent discharge, fever, leukocytosis, culture positive compared to uncoated endotracheal tube. In the present study, patients receiving an antibacterial endotracheal tube had a significant reduction in the incidence of VAP, which is consistent with the results of the study by Kollef et al. Contrary to our study, the results of Kollef's study showed no statistically significant difference between uncoated tube and silver-coated endotracheal tube in terms of secretion type, leukocytosis, fever and positive secretion culture. In other words, antibacterial and uncoated endotracheal tube did not have a statistically significant difference in terms of complications, but antibacterial endotracheal tube has an effective role in improving the prognosis of intubated patients and ICU length of stay. Silver-coated endotracheal tube had decreased the incidence of VAP than those receiving uncoated tube which is one of the most common nosocomial complications in intubated patients (18).

In another study, Tokmaji et al. (19) examined the role of silver-coated endotracheal tube and standard non-coated endotracheal tube in the reducing VAP and hospital mortality in 2081 patients in need of intervention. They found that silver-coated endotracheal tubes significantly reduced the incidence of VAP compared to standard non-coated tubes, which further confirms the findings of our study.In other words, coated endotracheal tubes is more useful than standard non-coated tubes in intubated patients. Tokmaji's study also noted that definitive outcomes of patients have not been obtained particulary during the first 10 days of intubation due to limited evidence, where require more extensive studies.In a review study by Li et al. (15), the role of silver-coated endotracheal tube versus non-coated tube in the incidence of VAP and mortality has been examined. They found that the use of silver-coated endotracheal tube was capable of reducing the incidence of VAP, device-related adverse events and microbiologic burden, confirming the findings of our study. However, Li's study also suggested conducting more rigorous randomized trials to confirm the above findings. The incidence of VAP in intubated patients in the ICU is one of the problems and is the cause of 50% of antibiotic prescription in these patients (7, 20, 21). VAP is also associated with increased mortality, ICU length of stay, and increased treatment costs (22). Therefore, it seems that antibacterial endotracheal tubes are one of the most effective intervention tools in reducing the incidence of VAP in these patients compared to standard non-coated endotracheal tubes, which can play an effective role in reducing hospital costs and complications associated with VAP in the ICU patients requiring intubation. To confirm these findings., additional rigorous randomized trials are needed due to the limitations of the studies and the small sample size in our study and other studies.

CONCLUSION

The results showed that antibacterial endotracheal tube significantly reduced the volume of discharge, purulent discharge, leukocytosis, fever and positive secretion culture compared to standard non-coated endotracheal tubes. In other words, antibacterial endotracheal tube played an effective role in the outcome of intubated patients admitted to the ICU as compared with those receiving standard non-coated endotracheal tubes. To confirm these findings., additional rigorous randomized trials are needed due to the limitations of the studies and the small sample size in our study and other studies.

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