ORIGINAL ARTICLE

Study of the effect of added bronchoscopic suction to routine treatment of ventilator associated pneumonia patients in surgical ICU

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Abstract

Objective: Comparing BAL and antibiotic therapy with antibiotic therapy itself for treating VAP patients in ICU.

Methods: In this randomized clinical trial, the first group was treated using antibiotics and closed-suction was performed daily, using 50 cc of sterile normal saline. The second group was treated with antibiotics and daily closed-suction with 50 cc of sterile normal saline, plus bronchoscopic suction every other day. Patients of both groups were followed and investigated one, 3, 7, and 10 days after initial diagnosis.

Results: Mean blood leukocyte count and body temperature was measured in groups one (no bronchoscopy) and two (with bronchoscopy) in first, 3rd, 7th, and 10th days which was higher in the second group. Mean treatment status was also measured using APACHE II index. There was also a statistically significant difference in 3rd day (p-value < 0.05). There was also no difference in final culture result or mortality rate between two groups.

Conclusion: According to the results of this study like lower body temperature, higher leukocyte count reduction, and lower APACHE II scores in the second group, treated with bronchoscopic suction, adding bronchoscopy seems to be more useful than normal method.

Keywords: Bronchoscopy, Pneumonia, VAP, APACHE II. (JPMA 71: 1326; 2021)

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Introduction

Usually there is no way to make sure whether the pneumonia is caused by a bacterial or viral infection at the time of its diagnosis, thus physicians commonly begin the treatment by prescribing the antibiotics.[1]

VAP is the cause of 20-70% of total mortality rate in the intensive care units accounting for half of antibiotic prescriptions for mechanically ventilated patients.[2,3] Mortality rate in VAP is higher than other types of hospital-acquired pneumonia, and it has been reported to be increased up to nearly 71%.[4] VAP is the cause of about 50% of hospital-acquired pneumonia cases[5] and 9-27% of mechanically ventilated patients with risk factors have been estimated to develop VAP soon after their admission.[6] Incidence of VAP is increased up to 6-12 times in patients who are on the ventilator for at least one day.[5,6]

Bronchoalveolar Lavage (BAL) method provides easy access to secretions of the bronchial tree, so that these secretions can be simply collected and removed by suctioning. Furthermore, the fluid can be suctioned after squirting sterile normal saline (SN) and washing the target part.[7] Currently, bronchoscopy using BAL is considered as one of medical procedures for VAP diagnosis.[8]

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Review of the literature shows that, antibiotic prescription has been the only treatment used for VAP so far; while, regarding VAP prevalence of 80% among hospital-acquired pneumonia types and its high mortality rate (71%) in comparison with other types of pneumonia, it seems crucial to provide a more comprehensive therapeutic solution for this disease. Based on a search in accessible databases, no research was found on the use of bronchoscopic suctioning (suctioning of the secretions in the patient's respiratory system) in treating VAP cases. Therefore, the present study is conducted to compare effectiveness of antibiotic-therapy accompanied with bronchoscopic suctioning and the sole antibiotic-therapy in treating the VAP.

Patients and Methods

The present interventional study was conducted with a randomised controlled clinical trial design. After approval of the study by the Ethics Committee with the ethics code of IR.BUMS.REC.139.136, it was registered at the Iranian Center for Clinical Trials (IRCT20140519017756N45 in Iran). After taking informed consent, all patients with renal diseases admitted to the Surgical Trauma Intensive Care Unit (STICU) of Imam Reza Hospital, Birjand, South Khorasan Province, Iran during 2018 were included. These patients had undergone tracheal intubation and mechanical ventilation and had been diagnosed 48 hours after mechanical ventilation as VAP.

Inclusion criteria were hospitalized patients undergoing

mechanical ventilation for more than 48 hours, no pregnancy, not being diagnosed with pneumonia 48 hours before intubation, no antibiotic consumption before intubation, lack of immune-deficiency diseases, and lack of immunosuppressive drug consumption.

Due to lack of a similar study for assisting in determining the sample size, a pilot study was conducted on twenty elementary patients comprising of 10 in the intervention group 1 and 10 in the intervention group 2. According to the comparison formula of two means, the sample size was calculated. Based on the results of the pilot study, related to the intervention group APACHE II index,9,10 on the first and fifth days, the following items were obtained and included in the sample size determination formula.

α=0.05, β=0.1, S_1=4.96, S_2=4.81, X α_1=18.2,X α_2=13.2

n=(([Z_(1-α/2)+Z_(1-β))] ^2 × (S_1^2+S_2^2))/(([X α_1-X α_2)] ^2)

The patients were selected by convenience sampling method and randomly divided into two intervention groups 1 and 2. The sample size included 42 patients, 21 of whom were in the intervention group 1 (or control group) and 21 of them were in the intervention group 2, and it increased to 50 subjects (25 subjects in each group) by considering a 19% attrition percentage. The chest X-ray and all the primary tests including ABG, K, Na, Cr, and CBC were performed for all the patients on the first day of intubation. The patients also underwent daily clinical examinations (lung and heart sounds, controlling of vital signs). In case of observing the signs and symptoms including abnormal changes in the body temperature (below 35°C or above 38°C) and changes in the colour and volume of airway secretion, the patient was suspected with pneumonia and thus, the chest X-ray and venous blood test were performed for the patient to evaluate the white blood cell count.

Moreover, lower respiratory tract secretions were obtained through lavage using a sterile catheter after infusion of 50cc of sterile normal saline and suctioning. The samples also underwent Pap smear test and culturing and then, the outcomes were sent to the laboratory (colony counts above than 104CFU/ml were considered positive). Also, number of extubated cases, expired cases, and another group other than the two study groups (those who have been examined until 10 days after infection with the VAP) were investigated in this study. All extubated cases and other cases of negative culture were considered as total number of the final negative culture, and all expired cases, along with the other cases of positive culture were considered as the final negative culture. Arterial blood samples were taken from patients by a physician, and then ratio of arterial oxygen blood pressure to inhaled oxygen concentration (PaO2/FiO2) was calculated. To diagnose the VAP, patients were examined using the Clinical Pulmonary Infection Scale (CPIS)[11,12] in which clinical, physiological, microbiological, and radiological evidence was used. The intervention group 1 (control group) received antibiotic therapy and underwent daily closed suctioning through infusion of 50cc of sterile normal saline.

For the intervention group 2, the bronchoscopic suctioning was performed in addition to antibiotic therapy and daily closed suctioning through infusion of 50cc of sterile normal saline. The bronchoscopic suctioning procedure was carried out by a specialist every 2 days. For this purpose, first, the secretions in non-engaged lung were suctioned by the bronchoscope until full drainage of the entire secretion. Then, residual secretions in the patient's respiratory canals were washed out using 100-200cc of 0.9% sterile serum normal saline with a temperature of 37°C. After accomplishing the procedure, the same process was performed for engaged lung. The bronchoscope was washed with water and betadine after each use, then it was disinfected in 2% glutaraldehyde disinfectant solution for 20 minutes, and finally it was rewashed by distilled water.

The process was continued 10 days after diagnosis by daily follow-up examinations of the patients in both groups. During this period, the information recorded up to the last day of examination was used in the cases that the examination became impossible for any reasons (such as expiration, discharge, removal of the tracheal tube, etc.).

The patients in both groups were daily examined for 10 days after diagnosis (in accordance with the ICU routine) for vital signs and APACHE II criteria.

All the patients admitted to the ICU underwent continuous routine monitoring accompanied with recording vital signs every 3 hours. Moreover, using an axillary thermometer, Patients' body temperature was measured for 7 minutes, as well as their blood pressure. In addition, pulse rates of patients were also measured for 30 seconds with a radial pulse, and then the rates were doubled.

Heart rate, systolic and diastolic blood pressure, and the Mean Arterial Pressure (MAP) were also measured and recorded by the monitoring instrument. Furthermore, blood samples were taken and sent to the laboratory to test serum level of sodium, serum level of potassium,

creatinine level haematocrit and the white blood cell count.

Collected data were analyzed by descriptive statistics, Kolmogorov-Smirnov test, ratio comparison test, regarding the normality of the studied variables (p> 0.05), independent sample T-test was used to compare mean body temperature, red blood cell count, etc. for the two groups. And to compare the mean of the mentioned variables in each group over three measurement items Repeated Measures ANOVA was used. SPSS software Ver. 22 at the confidence level of 0.05 was used.

Results

Among the study subjects, 37(74%) were male and 13(26%) were female. Mean age of the subjects was 45.68±19.76 and 44.40±19.51 (p>0.05) years, respectively in the first and second intervention groups.

Comparison of mean values indicated no significant difference in age, gender, underlying disease (systemic disease), and smoking (tobacco use) between the two groups.

No statistically significant difference was observed in mean body temperature of the patients on days 1, 7, and 10 in the two study groups (p>0.05), while on day 3, mean body temperature was significantly higher in Group 1 than the Group 2. Besides, a significant decrease was found in mean body temperature of subjects in both groups on day 10 compared to day 1 (P<0.05) (Table-1).

The blood leukocyte count significantly reduced over time (P<0.05), but there was no statistically significant difference between the two groups at different times (Table-2).

Also, there were statistically significant differences in mean blood oxygen concentration between the two groups at different times (P<0.05) (Table-3).

Mean value of the APACHE II index significantly reduced

Table-1: Comparison of the patients' mean body temperature.

Number of days after diagnosis	Group one (Without bronchoscopy)		Group two (With bronchoscopy)		P-value
	Mean	Standard deviation	Mean	Standard deviation	
First day	38.1	0.18	39	0.13	P=1
Third day	38.7	0.15	38.5	0.23	P=0.007**
Seventh day	38.2	0.41	38.2	0.22	P=0.98
Tenth day	37.91	0.38	37.91	0.17	P=0.95
Repeated measures of variance analysis	P<0.001**		P<0.001**		
Results of Bonferroni follow-up test	All times are significant with P<0.001 except Seventh day with tenth		All times are significant with P<0.001		

Table-2: Comparison of the blood leukocytes counts.

Number of days after diagnosis	Group one (Without bronchoscopy)		Group two (With bronchoscopy)		P-value
	Mean	Standard deviation	Mean	Standard deviation	
First day	20.39	2.49	20.65	2.30	P=0.7
Third day	19.18	2.29	18.04	2.02	P=0.07
Seventh day	14.17	1.96	13.46	1.95	P=0.32
Tenth day	12.03	3.48	11.67	2.14	P=0.78
Repeated measures of variance analysis	P<0.001**		P<0.001**		
Results of Bonferroni follow-up test	All times are significant with P<0.001		All times are significant with P<0.001		

Table-3: Comparison of the mean blood oxygen concentration.

Number of days after diagnosis	Group one (Without bronchoscopy)		Group two (With bronchoscopy)		P-value
	Mean	Standard deviation	Mean	Standard deviation	
First day	210.08	40.26	203.64	27.09	P=0.52
Third day	197.12	28.14	199.04	18.36	P=0.78
Seventh day	203.14	26.77	199.28	29.77	P=0.71
Tenth day	204.78	34.29	181.73	11.04	P=0.07*
Repeated measures of variance analysis	P=0.74		P=0.071		

Table-4: Comparison of improvement status based on APACHE II criteria.

Number of days after diagnosis	Group one (Without bronchoscopy)		Group two (With bronchoscopy)		P-value
	Mean	Standard deviation	Mean	Standard deviation	
First day	25.52	4.70	24.92	3.45	p=0.61
Third day	20.44	5.58	17.20	4.94	P=0.035*
Seventh day	9.93	4.49	9.65	3.46	P=0.85
Tenth day	8.8	3.85	6.73	4.41	P=0.27
Repeated measures of variance analysis	P<0.001 **		P<0.001**		
Results of Bonferroni follow-up test	All times are significant with P<0.001		All times are significant with P<0.001		

in both groups over time (P<0.05). Also, mean value of APACHE II index was significantly higher in the non-bronchoscopic group than the bronchoscopic group, only on the 3rd day (P<0.05) (Table-4).

Results of the study showed that, relative frequency of the final culture for the counts of 14(56%) and 11(44%) was in Group 1, and for the counts of 9(36%) and 16(64%) in Group 2 was positive and negative respectively, and also relative frequency of culture types was related to *Acinetobacter, Citrobacter, staph negative coagulase,* and *klebsiella*, respectively for the counts of 6(24%), 4(16%), 10(40%), and 5(20%) in Group-1 and 9(36%), 5(20%), 7(28%), and 4(16%) in Group-2. For both of them, comparison of the ratios showed no significant difference between the two groups.

According to the results of this study, a total of 4(16%) and 7(28%) cases were extubated and also 11(44%) and 7(28%) cases expired in Groups 1 and 2, respectively indicating no significant difference in terms of expiry rate.

For mean pre-VAP infection intubation time and mean CPIS, it showed no significant difference between the two groups for both variables(p>0.05).

Discussion

Bronchoscopic suctioning is one of the most important care services influencing on morbidity rate of pneumonia. Results of the present study showed a decrease in the mean body temperature and number of leukocytes in patients of both groups, but this reduction was greater in Group 2. Greater reduction of body temperature and number of leukocytes in Group 2 can be indicative of effectiveness of the bronchoscopic suctioning. In one study[13,] clinical values of the secretions obtained by bronchoscopic suctioning were compared to the values of secretions obtained by general suctioning in patients with COPD (Chronic Obstructive Pulmonary Disease). In another study[14] conducted on 360 patients with VAP, effectiveness of the bronchoscopic suctioning was determined for reducing the secretions,body temperature and WBC and the diagnosis of VAP, which were in agreement with results of the present study.

Results of this study indicated that, PaO2/FiO2 value was higher in the patients of Group 1, receiving only closed suctioning and antibiotic therapy, than those in the Group 2, on all days. In contrast to results of the present study, it has been indicated that, blood oxygen concentration was higher in the bronchoscopic group (220.87±9.06) than the other group (219.62±8.05) receiving general treatment.[13] Nevertheless, it should be noted that, the present study is one of the few studies conducted in this field.

The APACHE II scores used for predicting improvement showed lower values in Group 2 compared to Group 1 on all days, which were not significant. However, APACHE II scores showed a significant difference only on the 3rd day (P=0.035) and the lowest APACHE II score was obtained for Group 2 on the 10th day indicating effectiveness of the bronchoscopic suctioning for improvement of the patients, in comparison with routine method. It has been found that, the diagnostic bronchoscopy group had lower APACHE II scores in a shorter pre-diagnosis length of stay (P=0.02) compared to non-invasive group.[14] In another study entitled "The Use of Powerful Antibiotics for Patients with VAP", it has been indicated that, the use of several antibiotics during hospitalization increased with the increase in the APACHE II scores among patients with VAP.[15]

Staph negative coagulase and *acinetobacter* had the highest frequency in primary culture at the time of diagnosis in both groups. In this study, 56 and 36% of the cases were positive for the final culture after the treatment in Groups 1 and 2, respectively. In a study conducted on 188 records of the ICU-patients to investigate frequency of early VAP among the ICU-admitted patients, *Klebsiella, pseudomonas,* and staph were identified as the most common strains causing pneumonia.[16] Also in another study, *klebsiella* and *pseudomonas* were introduced as the most common strains causing lung infection.[17] However, in a study conducted to evaluate frequency of hospital infections

and related factors in the ICU of Mostafa Khomeini Hospital and based on NNI system (National Nosocomial Infections Surveillance System), *acinetobacter* was reported as the most common infecting strain, which is in agreement with the results of the present study.[18]

Number of deaths was equal to 44% and 28% in Groups 1 and 2, respectively, clearly indicating lower mortality rate in the bronchoscopic suctioning method. However, mortality rate is still high. In another study, 3 of 35 cases (8.5%) in the bronchoscopic group and 8 of 32 cases (25%) in the routine treatment group died, which is obviously different compared to those of the present study.[19] In a previous research, mortality rate of 18.1% 37%, and 27% was reported in the bronchoscopic, routine suction, and Taper Guard EVAC suction (A type of endotracheal tube that also has suction lumen and evacuation port) groups, respectively, which are approximately similar to results of the present study.[14,20]

Comparison of the pre-VAP infection intubation time among the patients indicated a longer duration in Group 2 (72.00±20.78), yet, this difference was not significant implying that the patients in Group 1 were infected with VAP earlier than those in the other group.

Other factors investigated in this study included CPIS score, history of underlying diseases, and history of smoking. In the present study, the scores of CPIS obtained from both groups were higher than 6; also, the risk of pneumonia was 1.1 times more in Group 1 than the Group 2. In the present study, 28% of cases had underlying diseases, among whom 6 patients belonged to Group 1 and 8 belonged to Group 2. In a study, 38% of the patients with pneumonia also had underlying disease;[12] whereas, it was equal to 25% in another study, which is to the results of the present study.[21] In terms of smoking, Group 1 with 15 smokers (60%) had the highest number of smokers, yet these values were not significant in the two groups. Results of another study indicated that, tobacco addiction increased morbidity in both groups.[22] Results of other studies implied the effect of smoking on incidence of pulmonary diseases including pneumonia. Accordingly, results of one study demonstrated that, tobacco addiction is one of the major risk factors for incidence of pneumonia, which is of course preventable.[23]

Conclusion

Findings of the present study including lower body temperature, further reduction of number of leukocytes, and lower mean score based on APACHE II criteria observed in subjects of Group 2 receiving bronchoscopic suctioning, indicated effectiveness of adding bronchoscopy in comparison with routine method applied for Group 1. The present work is among the first and pioneer studies in Iran conducted on the effect of adding the bronchoscopic suctioning to routine treatment of VAP. Although, lower mortality rate in treatment with bronchoscopy (28%) compared to the non-bronchoscopic treatment (44%) indicates significant effect of this approach, mortality rate in both groups is still very high in comparison with few foreign studies and even routine treatment approaches. Accordingly, it seems essential to apply further care and improve the methodology in future researches conducted on greater populations.

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