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The Effect of a Designed Respiratory Care Program on the Incidence of Ventilator-Associated Pneumonia: A Clinical Trial

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ABSTRACT

Introduction: Ventilator-associated pneumonia is a common complication of mechanical ventilation. This study aimed to evaluate the effect of designed respiratory care program on incidence of ventilator-associated pneumonia (VAP) in the mechanically ventilated patient.

Methods: In this clinical trial, 64 patients were selected among those who had undergone mechanical ventilation in the ICU of Al-Zahra Hospital, Isfahan, Iran, using convenience sampling method. The subjects were randomly allocated to intervention and control groups. In the intervention group an upper respiratory care program and in the control group, routine cares were done. Modified Clinical Pulmonary Infection Questionnaire was completed before and on the third, fourth and fifth day of study. Data were analyzed by Chi-square and independent t-test through SPSS Ver.13.

Results: The results of this study showed that until the third day of study, the incidence of VAP was similar in the both groups. However, on the fifth day of study, the incidence of VAP in the intervention group was significantly lower than control group.

Conclusion: The results of this study showed that an upper respiratory care program reduced the incidence of VAP. Therefore, nurses are recommended to perform this program for prevention of VAP.

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Introduction

Most of the patients hospitalized in the intensive care unit (ICU) due to acute respiratory failure require endotracheal intubation and mechanical ventilation.¹ One of the most common and serious complications among mechanically ventilated patients is the risk of ventilator-associated pneumonia (VAP).²⁻⁴ Hospital acquired pneumonia is the second common hospital infection after urinary tract infection and is often observed among the patients under ventilation.^{5,6} Incidence of pneumonia in the mechanically ventilated patients has been estimated 9-27%.⁷

One study reported that the incidence of VAP in general and intensive surgical units of Tehran, Iran were 22.5% and 18.2% respectively.⁸

VAP increases the treatment costs and mortality, and causes prolonged mechanical ventilation and hospitalization in the ICU.^{9,10}

Considering high prevalence and numerous physiologic and economic effects of VAP, the best strategy against VAP is control of its risk factors.¹¹ Nowadays, various interventions are suggested to prevent this complication, including head elevation of 30-45 degree, suctioning of the mouth and subgluteal space

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and regulating the pressure of cuff in the tracheal tube in the range of 20-30 cm H₂O.¹²⁻¹⁴

One of the interventions that can reduce the incidence of VAP is backrest elevation. In the clinical guideline of Disease Control and Prevention and clinical guideline of American ICU Nursing Association, it is recommended to elevate the backrest up to 30-45 degree among the patients with a tracheal tube.¹⁵ The results of a study showed that laying the patient in the supine position during the first 24hr of mechanical ventilation is indirectly associated with incidence of VAP and its mortality.^{16,17} Another study showed that elevation of the patients' backrest up to 45 degree, compared to supine position, significantly reduced the incidence of VAP.¹² Meanwhile, a study showed that laying patients' backrest in 45 degree elevation did not result in a reduction of VAP, compared to 10 degree of elevation.¹⁸

Another interventions that can diminish the VAP is lowering the risk of oral secretions aspiration.¹⁹ The results of a study showed that continuous suctioning of oral secretions plays a key role in reduction of VAP and shortening the length of mechanical ventilation and hospitalization in the ICU.¹³ Another study revealed that removal of oral secretions prior to a position change could reduce the incidence of VAP.²⁰

Another nursing care that can reduce the aspiration of the secretions remaining in the subgluteal space, is controlling and regulation of cuff pressure in the tracheal tube.²¹ If the cuff leaks or has inadequate pressure, the secretions over the cuff can leak to the airway and predispose the patient to VAP.^{14,22} If cuff pressure reaches less than 20 cm H₂O, the incidence of VAP could significantly increase. The results of a study demonstrated that the risk of VAP increased by four folds in the pressure less than 20 cm H₂O.¹⁴

In the ICU ward of Alzahra hospital in Isfahan, oral and subgluteal space suctioning in the mechanically ventilated patients is administrated every two hours, regardless of the time of patients' position change. There is no specific protocol to control and regulate the

cuff pressure, and the nurses regulate the cuff pressure in the different ranges. Although elevation of backrest is respected, there is no specific protocol for its degree and the nurses regulate that differently. Therefore, in the ICUs of Alzahra hospital in Isfahan, none of these methods is conducted with a unique protocol now.

There is no study that investigated the effect of simultaneous application of these three methods on incidence of VAP. Therefore, the researcher investigated the effect of simultaneous application of oral and sub gluteal space suctioning, elevation of backrest up to 45 degree and preservation of cuff pressure of tracheal tube in the range of 25 cm H₂O on incidence of VAP among the patients, mechanically ventilated in the ICUs.

Materials and methods

This was a single-blinded clinical trial on patients undergoing mechanical ventilation in the ICU of Al-Zahra Hospital, Isfahan, Iran. The sample size was calculated using the results of a study conducted by Vincent.²³

Based on the results of Vincent, and according to the type I error probability of 0.05 and a power of 0.8, the sample size was determined to be 32 patients for each group.²³

Convenience sampling method was performed for enrolling the participants. Allocating the subjects to the study and control groups was done randomly. An informed consent was obtained from the participants, and for unconscious patients, the consent was obtained from their relatives. Inclusion criteria were age over 18 years, being under ventilation for more than 24 hours, having no pneumonia or respiratory infection (at the time of entrance to hospital, before intubation and the first 48 hours of intubation) and the prohibition of backrest elevation, ordered by the physician. Exclusion criteria were parents' refusal to continue with the study, patients' expiration before the end of study, being extubated before the end of study, transfer to other wards or hospitals during study, and undergoing a surgery during study.

In this study, the instrument for data collection consisted of two parts. The first part included demographic and clinical information and the second part included Modified Pulmonary Infection Clinical Scale (MPICS). This is a standard scale including five criteria of body temperature, pulmonary secretion, WBC, PO₂- FiO₂ ratio based on mmHg and a chest X-ray. Each sub- scale is scored 0-2 in this tool and the maximum score is 10. Obtaining scores over five in this scale reveals involvement in VAP.^{24,25} The Persian version of Modified Pulmonary Infection Clinical Scale was used in the present study. Sabery et al., assessed the reliability of this scale through Cronbach alpha with internal consistency of 0.91.²⁶ This scale was completed before and on the third, fourth and fifth days of study at 8:00 o'clock by an anesthesiologist. The anesthesiologist did not aware of that the subjects belonged to each groups.

Firstly, the researcher explained the objectives and methodology of the study to hospital administrators, anesthesiologists, nurses and authorities of intensive care units of Al-Zahra Hospital, Isfahan, Iran and obtained their consent. Then the researcher attended in these units every day (from 7:00 to 19:00 o'clock) and randomly allocated the patients who met the inclusion criteria and had signed the consent form to study and control groups. In the night shifts (from 19:00 to 7:00 o'clock), a trained nurse colleague followed the study protocols.

After random allocation of the subjects to experimental or control groups, the researcher extracted all the demographic and clinical information of the patients and entered them in the first section of instrument. Before intervention, modified pulmonary clinical infection scale was completed for all the subjects. The subjects with VAP were excluded. Then, the researcher administrated a scheduled upper respiratory care in the study group. This intervention included oral sub gluteal space suctioning before each position change, measuring and regulating cuff pressure of tracheal tube in the range of 25 cm H₂O (twice a day at 8:00 and 20:00 o'clock),

and checking the backrest elevation at 45 degree by use of a bevel (twice a day at 8:00 and 20:00 o'clock). The intervention started when the consent was signed by each subject and carried out until fifth day. The subjects in the control group underwent upper respiratory routine care of Alzahra hospital. In the ICU ward of this hospital, oral and sub gluteal space suctioning in the mechanically ventilated patients is administrated every two hours, regardless of the time of patients' position change.

The Ethics Committee of Isfahan University of Medical Sciences approved the study. We obtained all permission of conduction this study. Participation in this study was completely voluntary and all patients signed the informed consent form.

Data were analyzed by using the Statistical Package for Social Sciences (SPSS Ver. 13). Independent t-test was used to check subjects' age homogeneity and Chi-square test was used for subjects' homogeneity concerning sex, hospitalization cause, and medical history, smoking history and immune system defects. Chi-square test was adopted to compare frequency of VAP between intervention and control groups.

Results

In the present study, 72 subjects in the two groups of intervention (n=35) and control (n=37) were studied. During the study, eight patients (three patient in the intervention and five patient in the control group) were excluded based on the exclusion criteria. Finally, 64 subjects in two groups of intervention (n=32) and control (n=32) were studied.

The mean (SD) of participants' age and duration of intubation in the intervention and control groups were 50.96 (18.7) vs. 49.50 (17.9) years and 3.12 (0.8) vs. 3.12 (0.9) days, respectively. Of the participants, 47% were women and 53% were men. The participants' causes of hospitalization were internal (29%), surgical (31%) and internal-surgical (40%) problems. Majority of the subjects had history of non- pulmonary diseases (45%) and were

non-smoker (70%). None of subjects had a history of immune system defect.

The results of Independent t-test and Chi-square test showed no significant differences in age, gender, duration of intubation, cause of admission, disease history, history of smoking and immune system defect between the two groups (Table 1) ($P > 0.05$).

Table two shows the frequency of VAP in the third, fourth and fifth days of study in the both intervention and control groups. According to this table, by increasing the

duration of intubation, the frequency of VAP increased in the both groups.

The results of the Chi-square test for between-groups comparison showed that on the third day of study, there was no significant difference between the study groups in terms of the VAP ($P > 0.05$). Meanwhile, on the fourth and fifth day of study the frequency of VAP was significantly lower in the intervention group, compared to control group (Table 2) ($P < 0.05$).

Table 1. Comparison of subjects' clinical and demographic characteristics in intervention and control groups

Groups	Intervention No (%)	Control No (%)	Chi-square test P-value
Gender			0.316
Male	19 (59.4)	15 (46.9)	
Female	13 (40.6)	17 (53.1)	
Hospitalization cause			0.864
Internal	9 (28.1)	10 (31.3)	
Surgical	11 (34.4)	9 (28.1)	
Internal –surgical	12 (37.5)	13 (40.6)	
Disease history			0.488
Pulmonary	9 (28.1)	6 (18.8)	
Non-pulmonary	15 (46.9)	14 (43.8)	
Absence of disease history	8 (25)	12 (37.5)	
Smoking history			0.784
Yes	10 (31.3)	8 (28.1)	
No	22 (68.7)	23 (71.9)	

Table 2. Comparison the frequency of VAP after intervention between the intervention and control groups

VAP	Group		Chi-square test P-Value
	Intervention group N (%)	Control group N (%)	
Third day			0.168
Yes	3 (9.4)	7 (21.9)	
No	29 (90.6)	25 (78.1)	
Fourth day			0.098
Yes	3 (9.4)	8 (25)	
No	29 (90.6)	24 (75)	
Fifth day			0.014
Yes	5 (15.6)	14 (43.8)	
No	27 (84.4)	18 (56.2)	

Discussion

The results of this study indicated that administration of upper respiratory care

including regulating the cuff pressure in the range of 25 cm H₂O, preservation of backrest elevation up to 45 degree and oral and subgluteal suctioning before patients'

position change reduced the incidence of VAP. Previous studies have not investigated the simultaneous and cumulative effect of these variables on VAP, but some studies investigated the effect of these interventions on VAP separately.

Consistent with our study, Drakulovic et al., showed that the elevation of patients' backrest up to 45 degree significantly decreased the incidence of VAP, compared to supine position¹². Chow et al., also showed that continuous oral suctioning has led to reduction of VAP.¹³ Furthermore, Rello et al. showed that regulation of cuff pressure over 20 cmH₂O has led to reduction of VAP.¹⁴ All of this study support the findings of our results.

Our results also showed that the incidence of VAP was similar until the third day of study in the both intervention and control groups. However, on the fourth and fifth days of study, the incidence of VAP was significantly lower in the intervention group, compared to control group. These findings reveal that in the long term period, conducting a designed upper respiratory cares can reduce the incidence of VAP.

Salimi et al., concluded that standardization of nursing cares in the long term (4 months) has reduced the incidence of VAP from 17.18 to 3.48%.²⁷ Grap et al., also concluded that in the long term period (seven days), the risk of VAP is higher among the patients with backrest elevation of lesser than 30 degree.²⁸ In addition, Chao et al., showed that oral suctioning before position change, in the long term, could reduce the incidence of VAP by 32%.²⁰

A reduction in the incidence of VAP, have reported from airway care protocols such as regulating the cuff pressure about 25 cm H₂O, preservation of backrest elevation up to 45 degree and oral and subgluteal suctioning before each position change seems to be associated with patients' secretions aspiration.^{14,15,22} Therefore, nurses can reduce the incidence of VAP through performing of such an

interventions in addition to other interventions.

Conclusion

Regulating the tracheal tube cuff pressure about 25 cmH₂O, preservation of backrest elevation up to 45 degree and oral and sub gluteal space suctioning before each position change can reduce the incidence of VAP. Therefore, nurses are recommended to use this method for prevention of mechanically ventilated pneumonia.

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Ethical issues

None to be declared.

Conflict of interest

The authors declare no conflict of interest in this study.

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