Original Article

The effect of an upper respiratory care program on incidence of ventilator-associated pneumonia in mechanically ventilated patients hospitalized in intensive care units

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Abstract

Background: Ventilator-associated pneumonia (VAP) is a common side effect in patients with an endotracheal tube. This study aimed to evaluate the effect of an upper respiratory care program on the incidence of VAP in mechanically ventilated patients.

Materials and Methods: In this clinical trial, 62 patients with endotracheal tube were selected and randomly allocated to intervention or control group. In the intervention group, an upper respiratory care program was performed and in the control group, routine care was done. Modified Clinical Pulmonary Infection Questionnaire was completed before, and on the third, fourth, and fifth day after intervention. Data were analyzed by repeated measure analysis of variance (ANOVA), chi-square, and independent t-test through SPSS 13.

Results: The results of this study showed that until the fourth day, the incidence of VAP was similar in both intervention and control groups ($P > 0.05$), but on the fifth day, the incidence of VAP in the intervention group was significantly lower than in the control group ($P < 0.05$).

Conclusions: The results of this study showed that in patients with an endotracheal tube, an upper respiratory care program may reduce the incidence of VAP. Therefore, in order to prevent VAP, nurses are recommended to perform this upper respiratory care program.

Key words: Nursing, suction, ventilator-associated pneumonia

Introduction

Proper function of respiratory system is essential to live. Preservation of an open airway is a crucial factor facilitating O2 and CO2 exchange.[1] Airway care and keeping it open for appropriate ventilation is a priority in the intensive care unit (ICU). Although preservation of a natural airway and avoidance of an artificial airway is a priority, when the patients are unable of preserving their airway naturally, application of an artificial airway is inevitable.[2,3] One of the most common and risky complications among mechanically ventilated patients is ventilator-associated pneumonia (VAP).[4-6] Hospital-acquired pneumonia is the second common hospital infection after urinary tract infection and is often observed among the patients under ventilation.[7,8] Incidence of pneumonia in mechanically ventilated patients has been estimated to be 9–27%.[9] Afhami *et al*. showed that the prevalence of VAP was 22.5% and 18.2% in general and intensive surgical wards of the hospitals affiliated to Tehran University of Medical Sciences, respectively.[10] VAP increases the treatment costs and mortality, and the length of being mechanically ventilated and hospitalized in the ICU.[11-13] With regard to the high prevalence and numerous physiologic and economic effects of VAP, the best strategy against VAP is its prevention and controlling the risk factors.[12] Nowadays, various strategies have been suggested to prevent VAP, including bed head elevation up to 30°–45°, suctioning the mouth and subgluteal space, and regulating the pressure of cuff in the tracheal tube in the range of 20–30 cm H_2O.

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Submitted: 04-Aug-14; Accepted: 09-Dec-14

One of the methods effective on reduction of VAP is bed head elevation. In the clinical guideline of Disease Control and Prevention and the clinical guideline of American ICU Nursing Association, it is recommended to elevate the bed head up to 30°–45° in the patients with a tracheal tube.[14] Kollef *et al*. and Lyerla *et al*. showed that laying the patient in the supine position during the first 24 h of mechanical ventilation is indirectly associated with the incidence of VAP and its mortality.[15,16] Drakulovic *et al*. showed that elevation of the patients' bed head up to 45°, compared to supine position, significantly reduced VAP.[17] On the other hand, Van Nieuwenhoven *et al*. showed that laying patients' bed head in 45° elevation did not result in a reduction of VAP, compared to 10° of elevation.[18] Another intervention to diminish VAP is lowering the risk of oral secretions' aspiration.[19] Chow *et al*. showed that continuous oral suctioning of oral secretions plays a key role in reduction of VAP and shortening the length of mechanical ventilation and hospitalization in the ICU.[20] Chao *et al*. showed that removal of oral secretions prior to a position change could reduce the incidence of VAP.[21] Another nursing care administered to reduce aspiration of the secretions remaining in the subgluteal space is controlling and regulating the cuff pressure in the tracheal tube.[22] If the cuff leaks or has inadequate pressure, the secretions over the cuff can leak to the airway and predispose the patient to VAP.[23,24] If the cuff pressure reaches less than 20 cm H_2O, the incidence of VAP is significantly increased. Rello *et al*. showed that the risk of VAP increases by fourfold in pressure less than 20 cm H_2O.[23] As indicated earlier, the methods that can affect the incidence of VAP include oral and subgluteal space suctioning before each position change, elevation of bed head up to 45°, and regulation of the cuff pressure to about 25 cm H_2O during the entire hospitalization time. In the ICU ward of Alzahra hospital in Isfahan, oral and subgluteal space suctioning in mechanically ventilated patients is performed every 2 h, 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 different ranges. Although elevation of bed head is followed, there is no specific protocol for its level in degrees and the nurses regulate this differently. Therefore, in the ICUs of Alzahra hospital in Isfahan, none of these methods are followed with a unique protocol now. No study has investigated the effect of simultaneous application of these three methods on the incidence of VAP. Therefore, the researcher investigated the effect of simultaneous application of oral and subgluteal space suctioning, elevation of bed head up to 45°, and preservation of cuff pressure of the tracheal tube in the range of 25 cm H2O on the incidence of VAP among the patients mechanically ventilated in ICUs.

Materials and Methods

This is a blind clinical trial. None of the subjects knew about the group that they were in. The study was approved by the ethics committee of Isfahan University of Medical Sciences and conducted on mechanically ventilated patients hospitalized in the ICUs of Alzahra hospital. Based on the report of Vincent *et al*., with first type error of 0.05 and test power of 0.80, the number of the subjects was calculated as 32 in each group.[25] Sampling followed was convenient sampling, and then, the subjects were assigned to study or control group through random allocation. An informed consent was obtained from all the patients (from their parents if the patients were unconscious). Inclusion criteria were age over 18 years, being under ventilation for more than 24 h, not having been affected by pneumonia or respiratory infection (at the time of entrance to hospital, before intubation, and during the first 48 h of intubation), and the prohibition of bed head elevation, ordered by the physician. Exclusion criteria were parents' refusal to continue with the study, patient's expiration before the end of study, being extubated before the end of study, transfer to other wards or hospitals during the study, and undergoing a surgery during the study.

Data collection tool had two sections. The first section included demographic and clinical characteristics and the second contained Modified Pulmonary Infection Clinical Scale. This is a standard scale including five criteria of body temperature, pulmonary secretion, WBC, PO_2–FiO_2 ratio based on mmHg, and a chest X-ray. Each subscale is scored 0–2 in this tool and the maximum score that could be obtained is 10. Obtaining scores over 5 in this scale reveals involvement in VAP [Table 1].[26,27] The Persian version of the Modified Pulmonary Infection Clinical Scale was used in the present study. Sabery *et al*. calculated the reliability of this scale through Cronbach's alpha and internal consistency was found to be 91%.[28] This scale was recorded on the third, fourth, and fifth days of the study at 8:00 AM. After random selection of the subjects and their allocation to study or control group, the researcher firstly extracted patients' clinical demographic data from their medical records in the hospital and recorded them in the first section of the data collection tool. Before intervention, the Modified Pulmonary Clinical Infection Scale was completed for all the subjects. The subjects with VAP were excluded. Then, the researcher performed a scheduled upper respiratory care in the study group, which included oral subgluteal space suctioning before each position change, measuring and regulating the cuff pressure of tracheal tube in the range of 25 cm H_2O (twice a day at 8:00 AM and 8:00 PM), and checking the bed head elevation at 45° by use of a bevel (twice a day at 8:00 PM). The subjects in the control group underwent upper respiratory routine care.

Data were analyzed by SPSS 13. Independent *t*-test was used to check subjects' age homogeneity and Chi-square test was used for subjects' homogeneity concerning sex, hospitalization cause, medical history, smoking history, and immune system defects. Independent *t*-test and repeated measure analysis of variance (ANOVA) were adopted to compare mean scores of Modified Pulmonary Clinical Infection Scale before and after intervention in the study and control groups.

Results

The present study was conducted on 72 subjects in two groups of intervention ($n = 35$) and control ($n = 37$) with participants who met the inclusion criteria. During the study, 8 subjects (3 in the study group and 5 in the control group) not meeting the inclusion criteria were excluded and the study was conducted on 32 subjects in the study and control groups. Mean ages of the subjects in suctioning intervention and control groups were 50.96 (18.7) and 49.50 (17.9) years, respectively. Subjects' intubation lengths in the study and control groups were 3.12 (0.8) and 3.12 (0.9) days, respectively. About 53% of the subjects were male and 47% were female. The cause of hospitalization was internal (29%), surgical (31%), and internal–surgical (40%). Most of the subjects had history of non-pulmonary diseases (45%) and were non-smokers (70%). No subjects had a history of immune system defect. Independent *t*-test and Chi-square test showed no significant difference in subjects' age, intubation length, sex, hospitalization cause, disease history, history of smoking, and immune system defect before intervention ($P > 0.05$) [Table 2]. Repeated measure ANOVA showed a significant difference in the trend of Modified Pulmonary Infection Clinical Scale score changes in the study and control groups ($P < 0.05$), but the difference was not significant between groups ($P > 0.05$). Independent t-test showed no significant difference in the mean scores of Modified Pulmonary Infection Clinical Scale before intervention and on the third and the fourth days after intervention, as both the groups showed similar changes ($P < 0.05$). Meanwhile, mean score of Modified Pulmonary Infection Clinical Scale was significantly lower on the fifth day after intervention in the study group, compared to the control group ($P < 0.05$) [Table 3].

Table 1: Modified clinical pulmonary infection score (MCPIS)

Criterion	Values	Score
Temperature	36-38.4	0
	38.5-39.8	1
	Less than 36 and over 39	2
WBC	4000-11,000	0
	Less than 4000 or over 11,000	1
	Over 500 WBCs (bands)	2
Pulmonary secretions	Absence of pulmonary secretions	0
	Existence of non-infectious pulmonary secretions	1
	Existence of infectious pulmonary secretions	2
Oxygenation: PO_2/FiO_2 ratio (mmHg)	Over 240 or existence of ARDS signs	0
	Less or equal to 240 and absence of ARDS signs	2
Chest X-ray	Existence of infiltration	0
	Disseminative infiltration	1
	Local infiltration	2

WBC: White blood cell

Table 2: Comparison of subjects' clinical and demographic characteristics in study and control groups

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

Discussion

Our obtained results showed that simultaneous administration of three modes of airway care including regulating the cuff pressure in range of 25 cm H_2O, elevation of bed head up to 45° and its maintenance at this position, and oral and subgluteal suctioning before each patient's position change resulted in a reduction in VAP. Previous studies have not investigated the simultaneous and cumulative effect of these variables on VAP, but some studies have been conducted on the effect of each of these methods on VAP. Drakulovic *et al*. also showed that elevation of patients' bed head up to 45° significantly decreased the incidence of VAP, compared to supine position, which is consistent with the present study.[17] Chow *et al*. showed that continuous oral suctioning led to lowered incidence of VAP.[20]

Rello *et al*. also showed that regulation of cuff pressure over 20 cm H_2O led to reduced incidence of VAP,[23] which

Table 3: Comparison of mean modified pulmonary clinical infection scale scores before and after intervention between the study and control groups

Time	Group mean (SD)		Independent *t*-test	
	Intervention	Control	*t*	*P*
Before intervention	2.15 (0.9)	2.21 (0.8)	−0.274	0.785
Third day	3.03 (1.1)	3.53 (1.2)	−1.651	0.104
Fourth day	3.25(0.9)	3.62 (1.2)	−1.342	0.185
Fifth day	3.18 (1.2)	4.03 (1.4)	−2.469	0.016
RMANOVA				
Measurement at different levels	*P*=0.000 *F*=27.595			
Between groups	*P*=0.029 *F*=4.971			

SD: Standard deviation, RMANOVA: Repeated measures analysis of variance

is consistent with the present study. Our results also showed that the incidence of VAP was similar until the fourth day after intervention in both study and control groups. But on the fifth day, the incidence of VAP was significantly lower in the study group, compared to control, which reveals the effect of conducting three simultaneous airway care protocols including regulating the tracheal tube cuff pressure to about 25 cm H_2O, maintenance of bed head elevation up to 45°, and oral and subgluteal space suctioning before each position change on the incidence of VAP.

Salimi *et al.* studied the effect of standard care including sterile suctioning of tracheal tube, mouth wash, and oral suctioning every 4 h, body position change and chest postural drainage every 2 h, encouraging the patient to cough every 2 h, fixing the head elevation at 30°, and washing hands before administration of care programs on the incidence of VAP and reported that conducting long-term standard airway care (4 months) led to the reduction of VAP from 17.18 to 3.48.[29]

Grap *et al.* also showed that the risk of VAP is higher among the patients with bed head elevation of less than 30°. The present study showed that an increase in bed head elevation up to 45° for seven straight days could reduce the risk of VAP in clinically critical patients. Chao *et al*. showed that oral suctioning before position change, in long term, could reduce the incidence of VAP by 32%.[21] A reduction in the incidence of VAP resulted from airway care protocols such as regulating the cuff pressure to about 25 cm H_2O, maintaining the bed head elevation up to 45°, and oral and subgluteal suctioning before each position change, which seems to be associated with aspiration of patients' secretions.[14,23,24] Therefore, nursing staff can reduce the incidence of VAP through administration of such an intervention in addition to other interventions, thereby decreasing the risk of patients' aspiration. There were two limitations in the present study: the absence of an identical tracheal tube suctioning method and not administering an identical respiratory physiotherapy in the patients that could have affected the incidence of VAP. These two limitations might have affected the results obtained in our study.

Conclusion

Regulating the tracheal tube cuff pressure to about 25 cm H_2O, maintaining the bed head elevation up to 45°, and oral and subgluteal space suctioning before each position change led to lowered incidence of VAP. The nurses are recommended to consider this issue in giving care to mechanically ventilated patients.

Acknowledgments

This article was derived from a master thesis of Bahrami Nasim with project number 393161 Isfahan University of Medical Sciences, Isfahan, Iran. with clinical trial code of IRCT2013122215898N1. The authors greatly appreciate the kind cooperation of vice chancellery for research in Isfahan University of Medical Sciences as well as the staff in the ICU wards of Alzahra hospital in Isfahan who helped them with this research.

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How to cite: Bakhtiari S, Yazdannik A, Abbasi S, Bahrami N. The effect of an upper respiratory care program on incidence of ventilator-associated pneumonia in mechanically ventilated patients hospitalized in intensive care units. Journal of Nursing and Midwifery Research 2015;20:354-8.

Source of Support: Isfahan University of Medical Sciences, **Conflict of Interest:** Nil