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The Comparison of the Effect of the Head of Bed Elevation to 30 and 45 Degreess on the Incidence of Ventilator Associated Pneumonia and the Risk for Pressure Ulcers: A Controlled Randomized Clinical Trial

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Abstract

Background: The prevention of ventilator-associated pneumonia (VAP) can decrease the duration of mechanical ventilation, length of hospital stay, mortality, and healthcare costs.
Objectives: The aim of this study was to compare the effect of the elevation of head of bed (HOB) to 30 and 45 degreess on the incidence of VAP.
Methods: This study was a 3 group controlled randomized clinical trial. It consisted of 120 patients who were under mechanical ventilation and hospitalized in the intensive care unit (ICU) from February to July 2016 in the selected governmental hospitals of Iran University of Medical Sciences. The patients were allocated into 3 groups. The patients of intervention groups received interventions consisting of HOB elevation to 30 and 45 degreess for 3 consecutive days. The patients in the control group were in the routine position in the bed for 3 consecutive days. The HOB elevation was measured using the goniometer and recorded by nurses in perticular forms. At the end of the third day, VAP and pressure ulcers were evaluated using the clinical pulmonary infection score (CPIS) as well as Braden scales. The data were analyzed using descriptive and inferential statistics.
Results: Statistically significant differences were reported in terms of VAP between the groups of the HOB evelation to 30 degrees (32.50%) and 45 degrees (20.00%) and control groups (52.50%) ($P = 0.01$). However, the mean scores of pressure ulcer showed no statistically significant differences between the groups ($P = 0.625$). The greatest change in position was performed by the staff nurses for nursing care in the group of 45 degrees elevation that reported as 6.125 ± 3.13 hours.
Conclusions: The HOB elevation to 45 degrees helped with the prevention of VAP compared with the HOB elevation to 30 degrees as well as bed routine. Therefore, it is suggested that nurses elevate HOB to 45 degrees (more than 30 degrees) among mechanically-ventilated patients admitted to the ICU.

Keywords: Patient Positioning, Ventilator-Associated Pneumonia, Pressure Ulcer

1. Background

Ventilator-associated pneumonia (VAP) is the most common nosocomial infection that affects 28% of patients hospitalized in the intensive care unit (ICU) (1). VAP is the second most common healthcare-associated infection in the United States (2). VAP occurs in patients who are receiving mechanical ventilation for more than 48 hours (3). VAP is the most common nosocomial infection in critically ill patients and in patients under mechanical ventilation (4). It increases the duration of mechanical ventilation, hospital stay, and patient's mortality (5). Risk factors for VAP are the prescription of proton pump inhibitors' medications, sedatives, neuromuscular paralyzing agents, blood transfusions more than 4 units, monitoring the intracranial pressure, mechanical ventilation for more than 2 days, positive end expiratory pressure (PEEP), inserting the endotracheal and nasogastric feeding tubes, sleeping in the supine position, hospitalization in the ICU, and previous treatment with antibiotics (6). Other risk factors for VAP are endotracheal intubation and tracheostomy. Endotracheal tube significantly disturbs the mechanism for airway protection and causes local inflammation (7). Therefore, the prevention of VAP would be a major challenge and priority in the care of critically ill patients (2, 8).

Raising HOB, rinsing with Chlorhexidine, prophylactic medications for deep venous thrombosis, prevention of

aspiration, hand washing, less use of sedatives, and early weaning of mechanical ventilation reduces VAP (9). The prevention of VAP reduces the duration of mechanical ventilation, length of hospital stay, mortality, and healthcare costs (10). Another preventive method in patients undergoing mechanical ventilation is raising HOB to 30 degrees or more (11). According to clinical guidelines related to the prevention of pneumonia and aspiration, HOB should be elevated to 30 - 45 degrees among mechanically ventilated patients (12). Clinical guidelines also recommend that HOB should not be raised to more than 30 degrees for the prevention of pressure ulcers (13). Raising HOB to more than 30 degrees increases the shear stress and causes pressure ulcers. For the prevention of pressure ulcers in the sacral area, clinical guidelines recommend that HOB should remain less than 30 degrees under any circumstances (14). Differences in clinical guidelines for the prevention of aspiration and pressure ulcers cause many problems for physicians and other healthcare providers (15).

According to a survey, the actual size of raising HOB for reducing VAP and pressure ulcers is unknown (16). There is a need to study the relationship between pneumonia and pressure ulcers and different degrees of HOB, especially among patients undergoing mechanical ventilation who have the nasogastric feeding tube (5). Prevention at the intensive care unit (ICU) is an important element. Therefore, it seems necessary to study methods to reduce VAP in patients under mechanical ventilation. Furthermore, according to our comprehensive search of scientific databases, there are no published studies that compared the effect of HOB elevation to 30 - 45 degrees on the incidence of VAP and pressure ulcer together in the patients under mechanical ventilation hospitalized in the ICU.

2. Objectives

The aim of this study was to compare the effect of the elevation of HOB to 30 and 45 degrees on the incidence of VAP.

3. Methods

3.1. Design

This study was a 3 group controlled randomized clinical trial. The study consisted of 120 patients undergoing mechanical ventilation and hospitalized in the intensive care unit (ICU) from February to July 2016 in the selected governmental hospitals in Tehran, Iran. These hospitals included: Firoozgar, Rasoul-e Akram, and Haft-e Tir.

3.2. Participants

The 120 patients undergoing mechanical ventilation and hospitalized in ICUs were selected. They were chosen using a convenience sampling method. The inclusion criteria included: age higher than 18 years, having no history of VAP, being hospitalized in the ICU, being under mechanical ventilation support for eight hours after hospitalization, having no injuries in the spine, and no pelvic unstable fracture. The exclusion criteria included: patient death, remaining in the selected positions for less than 6 hours at the last 24 hours, and a positive history of pressure ulcers with the elevation of HOB to 45 degrees led to the exclusion of the patients. No patients were excluded during the study.

3.3. Data Collection

The demographic data form, clinical pulmonary infection score (CPIS), acute physiology and chronic health evaluation (APACHE II), Braden scale, and the skin condition documentation form were used for data collection by one of the researchers. Ten experts (professors of nursing in the Nursing and Midwifery Faculty of Iran University of Medical Sciences) confirmed the validity of the instruments.

3.4. Demographic Data Form

All participants completed a questionnaire containing 9 questions regarding demographic information and disease history. This form was filled out before interventions through interviewing with the patients and reading their health files in the ICUs.

3.5. Clinical Pulmonary Infection Score (CPIS)

The CPIS was designed by Pugin et al. (1991), with the aim of VAP evaluation. The sensitivity and specificity of the CPIS were reported as 93% and 100%, respectively. This form consisted of questions regarding the body temperature, white cell count, pulmonary secretions' color, Pao_2/FIo_2, chest radiography, sputum smear, and culture. The validity and reliability of this form were approved by a previous study (17). The range of scores given to the questions varied between 0 and 2 as follows: body temperature: 36.5 - 38.4 = 0, 38.5 - 38.9 = 1, < 36 and > 36 = 2; white cell count = 1000 - 4000 = 0, < 4000 and > 11,000 = 1, and > 500 = 2; no pulmonary secretion = 0, non-purulent discharge = 1, and purulent secretions = 2; $Pao_2/Fio_2 < 240$ or the acute respiratory distress syndrome (ARDS) = 0 and $Pao_2/Fio_2 > 240$ and no ARDS = 2; the absence of infiltration on the chest radiography = 0, diffuse infiltration = 1 and local infiltration= 2; the absence of pathogenic bacteria in sputum smear and culture = 0, pathogenic bacteria in sputum culture = 1 and some pathogenic bacteria in the smear = 2.

If the total score was equal to or greater than 6, the patient was considered to have VAP. This form was filled out at the end of the third day and up to 6 hours after it for each patient. The chest radiography was performed using a portable device and a physician collaborated for the diagnosis of lung infiltration. The sputum culture and white cell count tests were performed. The method of collecting the sputum culture in all hospitals was non-bronchoscopic aspiration of tracheobronchial secretions (Mini BALL). Additionally, a physician was asked to document data regarding the patient's condition and to check the related details.

3.6. Acute Physiology and Chronic Health Evaluation (APACHE II)

The APACHE II form was used to predict the risk for death in the first 24 hours after hospitalization for patients with different diagnoses in the ICUs. This form was designed for the first time by Knaus et al. in a study with 5815 patients admitted to the ICUs of 13 hospitals. This form consisted of 3 parts, which were the following: The first part contained 11 items regarding the measurement of physiological variables and Glasgow coma scale (GCS). The minimum and maximum scores of each item in the physiologic domain were 0 and 4, respectively. For the calculation of the GCS score in the physiological domain, the score 15 was reduced from the score of the patient's level of consciousness and documented as the score of physiologic domain. Indicators for the evaluation of physiological domain were temperature, mean arterial pressure, heart rate, respiratory rate within 1 minute, Pao_2, the arterial blood PH, sodium and potassium concentrations (Meq/dL), serum creatinine (mg/dL), hematocrit (percentage), and the white blood cell count. The score range of the physiologic domain was 0 - 59. The second part was related to the score given based on the patient's age with a range of 0 - 6. The third part was related to the evaluation of chronic diseases and organ failures. The range of the total score for the APACHE II was 0 - 71 indicating the percentages of the probability of patient death as follow: score 0 - 4 = 4%; score 5 - 9 = 8%; score 10 - 14 = 15%; score 15 – 19 = 25%; score 20 - 24 = 40%; score 25 - 29 = 55%; score 30 - 34 = 75%; score > 34 = 85% (18). Aminiahidashti et al. (2016), in a study done on the predictive power of APACHE II in the emergency department confirmed that this scoring system had the sensitivity of 85%, specificity of 48%, and the precision of 63.4% (19).

3.7. Braden Scale

The Braden scale was used for predicting the risk for pressure ulcers. It consisted of 6 domains: activity, mobility, sensory perception, nutrition, humidity, and shear stress. The scoring of this form was from 1 (very bad) to 4 (very good) with a lower score indicating a high risk for pressure ulcers. According to the scores, the risk for the development of pressure ulcers was classified as follows: low risk = 16 - 18, intermediate risk = 13 - 15, high risk = 12, and very high risk < 9. The first time this form was used was by Pang and Wong (1998) and its validity and reliability were confirmed (20). Soozani et al. (2011) demonstrated that this tool had a sensitivity of 92% and specificity of 74% for predicting pressure ulcers (21).

3.8. Skin Condition Assessment Form

The skin condition assessment form consisted of 5 questions that assessed the early signs of pressure ulcers as follows: does the patient have the red pressure zones? Do the redness areas remain constant in pressure areas? Does the redness fade after three seconds of pressing? Are there abrasion or blisters in the areas of pressure ulcers? Is there a deep wound in pressure areas?

3.9. Intervention

At the beginning, the aims of the study were explained to the patients' family. Participation in this study was completely voluntary and free from any obligation for the physician, nursing staff, or researchers. The random permuted block method was used. The patients were divided into 3 groups as follows: a control group (routine position in the bed) and intervention groups (HOB elevation 30 and 45 degrees). The eight permuted blocks consisted of A, B, C; B, A, C; C, A, B; C, B, A; B, C, A; A, B, A; B, A, B; and A, C, B. Various modes of allocation were written on cards and placed in sealed opaque envelopes in a box. Next, a staff nurse who was unaware of the groups' allocation methods was requested to choose envelopes and determine the allocation of patients into the groups. This was continued until the desired number of patients were chosen and allocated into the groups (Figure 1).

Before the intervention, the researcher explained the aim of the study as well as the method, how to measure the slope of the bed using a calibrated goniometer, methods for the prevention of pressure ulcers, and VAP to staff nurses in ICUs. Nurses were asked to play as the role of research assistants. Next, the patients in 2 intervention groups received interventions consisting of the HOB elevation to 30 and 45 degrees. The patients in the control group received routine care.

The APACHE II form was filled out for all patients in the groups in the first 24 hours after hospitalization in the ICUs. The Braden scale was used for predicting the risk for pressure ulcers for 3 consecutive days. If any patient developed pressure ulcer grade I as the red discoloration of

the skin without pinching the sacral area (the most common site of pressure ulcers), the patient was excluded from the study and referred to specialists for further treatment. The incidence of pressure ulcers in the groups was documented and compared together. None of the patients who were recruited in this study developed pressure ulcers.

In all 3 groups, the slope of the HOB was measured using a calibrated goniometer at each work shift by the nurse and documented in the perticular form. Changes in the patients' positions for performing nursing interventions were recorded and soon after the procedure, HOB was repositioned to 30 or 45 degrees as instructed.

Moreover, the following measures were taken in all 3 groups for the prevention of pressure ulcer and VAP consisting of changing the position every 2 hours, assessment of pressure areas during position changing, changing wet sheets, lifting the patient instead of shearing the patient on the bed, washing hands, rinsing with Chlorhexidine, and performing oral as well as tracheal suction when needed. At the end of the third day, the CPIS was used to assess the incidence of VAP.

3.10. Sample Size and Data Analysis

The sample size was determined to include 35 patients in each group using a sampling formula with the consideration of 0.05 alpha, 80% beta, and 25% the effect size for the reduction of VAP according to the previous study (Schallom et al. 2015). The prevalence of VAP among Iranian patients was reported as 0.3. Furthermore, considering a 10% probability of subject attrition, a total of 40 people were assigned into each group as the final sample size. Using a sampling formula, the sample size was determined to include 120 patients.

$$n = \frac{\left(z_1 \frac{\alpha}{z\sqrt{2\overline{pq}} + z_1 - \beta\sqrt{p_1 q_1 + p_2 q_2}}\right)^2}{(p_1 - q_1)^2}; \overline{p}\frac{p_1 - p_2}{2} \quad (1)$$

According to the Kolmogorov-Smirnov test, the distribution of the data was normal. The data were analyzed via per-protocol analysis using descriptive and inferential statistics. The one-way ANOVA and Scheffe ad hoc tests were used for the comparison of the means of age, body mass index (BMI), APACHE II scores, and the scores of Braden scale between the groups. The comparison of gender and the history of diseases was performed using the Chi-Square test. In addition, logistic regression was used for the evaluation of the effect of different variables on VAP. The data analysis was performed via the statistical package for the social sciences (v.20) (SPSS Inc, Chicago, USA) and $P < 0.05$ was considered statistically significant.

3.11. Ethical Considerations

All codes of ethics that must be observed in a clinical trial were implemented in this study. This study was approved by the research ethics committee of Iran University of Medical Sciences (registration code IR.IUMS.REC.1394.9311449007). The clinical trial registration number was: IRCT2015120225345N1. The aims of the study were explained in detail to the participants and their families. Participation in this study was completely voluntary and free from any obligation to the physician, nursing staff or researchers. All patients and their families gave informed written consent. The patients' skin condition was assessed and appropriate care was provided to patients with pressure ulcers. None of the patients in this study developed pressure ulcers. The patients and their family members were informed of the study aim and process. Furthermore, the patients' companions were asked to sign the informed written consent form.

4. Results

4.1. Demographic Characteristics

The questionnaire response rate was 100%. Most of the participants were males (60.00%) and married (63.57%). The mean age of the patients in the intervention group was 64.76 $\pm$ 18.35 years for HOB elevation to 30 degrees and 55.75 $\pm$ 16.41 years for HOB elevation to 45 degrees, with a range of 40 - 90 years. The mean age of the patients in the control group was 64.02 $\pm$ 20.24 years with a range of 40 - 85 years. Most of the chief complaints of patients were neurologic disorders (39.1%). Most of the participants were overweight (58.3%). For most of the participants, sedatives were used (49.83%). Additionally, the groups had statistically significant differences in terms of the risk for death 24 hours after hospitalization (P = 0.012). The Scheffe ad hoc test showed that there were differences between the intervention groups and the control group (P = 0.032). As it is shown in there there were no significant differences between the intervention and control groups with regards to various characteristics such as age, sex, and other demographic variables.

4.2. Pressure Ulcer

The mean of probability of pressure ulcer within 3 days w the analysis of variance test showed that there was no statistically significant difference in terms of the mean of the probability of pressure ulcers according to the Braden scale (P = 0.652). Furthermore, none of the patients in the groups suffered from pressure ulcers after 3 days.

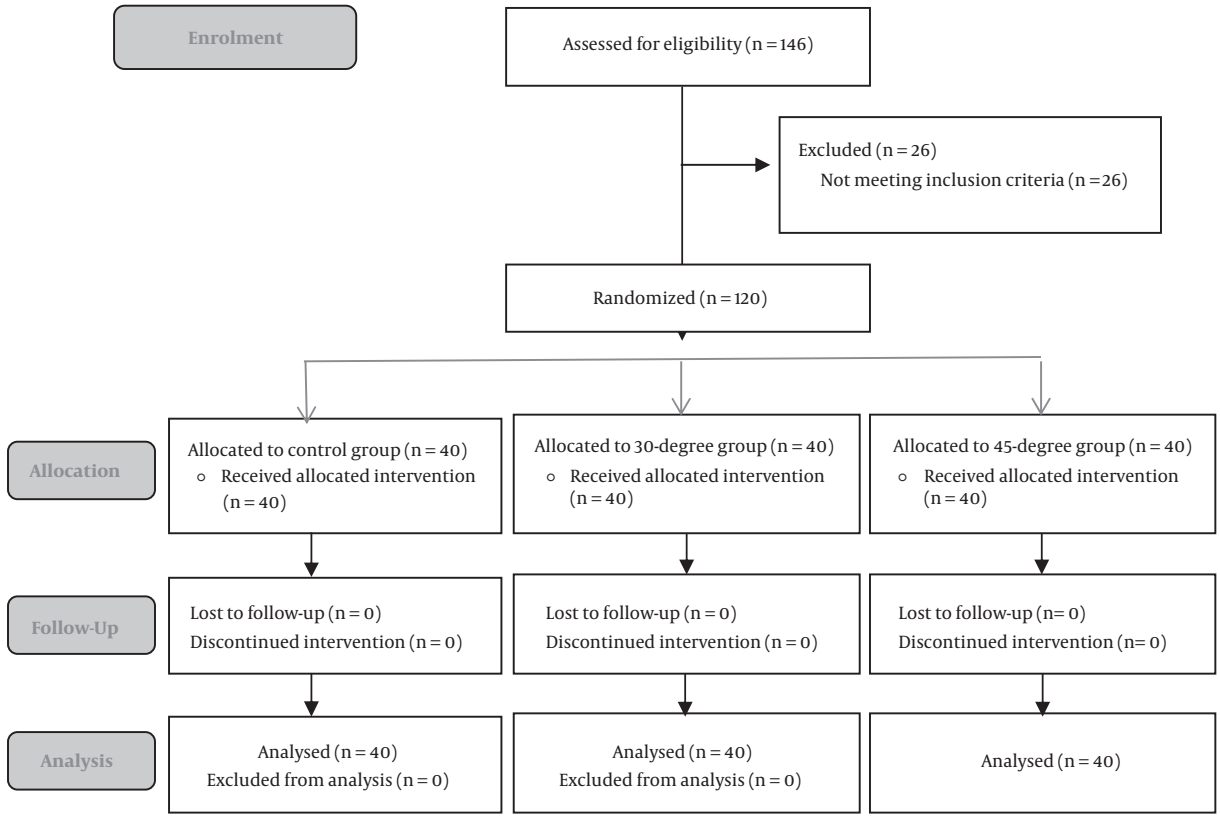

Figure 1. The Process of Recruitment and Allocation of Patients to the Groups

4.3. Head of Bed Elevation

As it is shown in Table 1 the mean of the HOB elevation in the control group was 21.25 $\pm$ 3.85. The mean of the HOB elevations in the interventions groups were 29.38 $\pm$ 1.13 and 43.15 $\pm$ 1.88 for the HOB to 30 and 45 degrees, respectively. The mean of the changes in the elevation of HOB, causes, and duration of changes (in hour unit) are shown in Table 2. The greatest change in position performed by the staff nurses for nursing care in the group of 45 degrees elevation was reported as 6.125 $\pm$ 3.13 hours (Table 2).

4.4. Ventilator-Associated Pneumonia

The results of the Chi square test confirmed that there was a statistically significant difference with regards to VAP after 3 days (P = 0.01, χ^2 = 9.451). It was noted that 52.50% of the patients in the control group suffered from VAP. VAP in the intervention groups was reported as 32.50% and 20.00% in 30 degrees as well as 45 degrees groups, respectively. Also, the patients in the 45 degrees group suffered less (12%) from VAP compared to the 30 degrees group.

As it is shown in Table 3, age, BMI, and probability of death were not statistically significant in the regression model. The HOB to 30 degrees did not have any statistically significant difference compared to the control group (P = 0.179). However, HOB to 45 degrees had statistically significant differences compared to the control group (P = 0.038). Additionally, the odds ratio for the group of 45 degrees was 0.311 compared to the control group. In other words, the risk of VAP was 3 times more in the control group compared to the HOB to 45 degrees. The HOB to 30 and 45 degrees were not statistically significant regarding to the incidence of VAP (P = 0.459).

5. Discussion

This study assessed the impact of HOB elevation to 30 and 45 degrees on the incidence of VAP in patients hospitalized in the ICU who were under mechanical ventilation. The HOB 30 to 45 degrees can decrease the incidence of VAP in patients with the HOB elevation to 30 - 45 degrees compared to the control group. The results showed that HOB elevation to 30 to 45 degrees significantly reduced the incidence of VAP. Moreover, Biagio showed that raising the

Table 1. The Demographic Characteristics of the Patients in the Groups[a]

Variable		Groups			Test Results	P Value
		30 Degrees	45 Degrees	Control		
Age, y		64.76 ± 18.35	55.75 ± 16.41	64.02 ± 20.24	F = 2.936	0.057
Gender	Male	24 (60.00)	26 (65.00)	22 (55.00)	χ^2 = 0.833	0.659
	Female	16 (40.00)	14 (35.00)	18 (45.00)		
Marital status	Single	5 (12.80)	6 (16.20)	2 (5.30)	Fisher exact test	0.354
	Married	34 (87.20)	31 (8.83)	36 (94.70)		
Chief complaint	Sepsis	2 (5.00)	6 (15.00)	4 (10.00)	Fisher exact test 0	0.0112
	Neurologic disorders	14 (35.00)	11 (27.50)	22 (55.00)		
	Trauma	10 (25.00)	12 (30.00)	3 (7.50)		
	Malignancy	8 (20.00)	4 (10.00)	6 (15.00)		
	MI	3 (7.50)	3 (7.50)	4 (10.00)		
	Other	3 (7.50)	4 (10.00)	1 (2.50)		
Comorbidities	Yes	24 (60.00)	30 (75.00)	28 (70.00)	χ^2 = 2.157	0.340
Probability of death		24.5 ± 17.00	244 ± 19.97	27.5 ±17.03	F= 4.583	0.012
	15%	1 (2.50)	0 (0.00)	0 (0.00)		
	25%	5 (12.50)	8 (20.00)	1 (2.50)		
	40%	12 (30.00)	15 (37.50)	12 (30.00)		
	55%	14 (35.00)	9 (22.50)	16 (40.00)		
	75%	8 (20.00)	7 (17.50)	7 (17.50)		
	85%	0 (0.00)	1 (2.50)	4 (10.00)		
BMI		26.20 ± 0.80	25.20 ± 0.70	25.20 ± 0.54	F = 0.645	0.526
	Normal	12.00 ± 33.30	14.00 ± 40.00	13.00 ± 36.10		
	Overweight	23.00 ± 63.90	18.00 ± 51.40	22.00 ± 61.10		
	Obese	1.00 ± 2.80	3.00 ± 8.60	1.00 ± 2.80		
Degree of HOB elevation		29.38 ± 1.13	43.15 ± 1.88	21.25 ± 3.85		
Probability of pressure ulcer	1st day	12.00 ± 2.42	11.51 ± 2.03	11.92 ± 2.51	F = 0.489	0.614
	2nd day	11.63 ± 2.96	11.51 ± 2.03	11.92 ± 2.51	F = 0.278	0.757
	3rd day	11.73 ± 2.62	11.17 ± 2.57	11.92 ± 2.51	F = 0.893	0.412
	Total	12.00 ± 2.40	11.55 ± 2.02	11.67 ± 2.28	F = 0.429	0.652
Drug	Narcotics	11 (40.70)	10 (52.60)	14 (51.90)	Fisher exact test	0.474
	Sedatives	16 (59.30)	8 (42.10)	13 (48.10)		
	Neuro muscles blocking	0 (0.00)	1 (5.30)	0 (0.00)		

Abbreviations: BMI, body mass index; HOB, head of bed; MI, myocardial infarction; SD, standard deviation.
[a]Values are expressed as No. (%) or mean ± SD.

HOB to more than 30 degrees can prevent the reflux of gastric contents into the oropharyngeal area and therefore, reduce the chance of aspiration and pneumonia (22).

In this study, the patients with the HOB elevation to 45 degrees were affected by VAP 12.5% less than the patients with the HOB elevation to 30 degrees; however, the difference was not statistically significant. Such a result has a clinical significance indicating the need for the HOB elevation to 45 degrees (more than 30 degrees). In line with this study, Alexiou et al. reported that patients who received the HOB elevation to 45 degrees, had a lower rate of VAP and mortality compared to patients in the prone position

Table 2. Changing Positions and Its Duration in the Intervention Groups[a]

Causes of the Changing Position	45 Degrees (n = 40)		30 Degrees (n = 40)	
	Frequency	Duration, h	Frequency	Duration, h
Nursing care	16 (40.00)	6.125 ± 3.13	28 (70.00)	5.74 ± 2.50
Diagnostic procedures	7 (17.50)	1.07 ± 1.31	22 (55.00)	0.061 ± 0.028
Treatment	14 (35.00)	1.76 ± 0.85	8 (20.00)	3.61 ± 3.53
Without the recognizable cause	12 (30.00)	1.65 ± 0.00	1 (2.50)	1.65 ± 0.00

Abbreviation: SD, standard deviation.
[a]Values are expressed as No. (%) or mean ± SD.

Table 3. The Logistic Regression Analysis of Variables Influencing VAP

Variable		Incidence	SD	P Value	OR	95% CI
Group	Control	Reference point				
	30 degrees	-0.693	0.515	0.179	0.500	(0.182, 1.373)
	45 degrees	-1.169	0.563	0.038	0.311	(0.936, 0.103)
Age, y	> 80	Reference point				
	< 40	-0.458	0.800	0.565	0.633	(0.132, 3.034)
	40 - 49	0.300	0.775	0.699	1.349	(0.296, 6.156)
	50 - 59	-1.273	0.800	0.112	0.280	(0.058, 1.344)
	60 - 69	0.211	0.648	0.745	1.234	(0.347, 4.395)
	70 - 79	0.693	0.689	0.314	1.999	(0.518, 7.710)
BMI	Fatty	Reference point				
	Normal	0.003	1.256	0.998	1.003	(0.086, 11.75)
	Over weight	0.308	1.234	0.803	1.361	(0.121, 15.28)
Probability of death	-	-0.078	0.042	0.334	1.047	(0.954, 1.150)

Abbreviations: BMI, Body mass index; CI, Confidence interval; OR, Odds ratio; SD, Standard deviation.

or decubitus position, i.e., lying on their back (23). Charles et al. reported that HOB elevation to 0 degree was an independent risk factor for VAP (24). Ayzac et al. indicated that the patients who were in HOB elevation to 45 degrees had a lower rate of VAP in comparison to the patients in the prone position (44.1% versus 55.9%). Nevertheless, there were no statistically significant differences (25).

Also, no statistically significant difference was reported between the group of HOB elevation to 30 degrees and control groups in terms of VAP. This could be attributed to lower mean of the HOB elevation and the failure to remain constantly in this slope during three consecutive days. Metheny et al. reported a higher rate of VAP in patients with the HOB elevation to more than 30 degrees (26). Another study reported that semi-sitting position (30 - 60 degrees) significantly reduced the risk of VAP compared to supine position (0 - 10 degrees). However, no statistically significant differences were reported between the groups in terms of mortality in the ICU, the duration of stay, duration of mechanical ventilation support, use of antibiotics, and pressure ulcers (27). No comparison was made between the HOB elevation to 30 and 60 degrees and adherence to such slopes by the patients.

The prevention of VAP is affected by appropriate supporting interventions, removing nursing shortages, and education of nursing staff. Bakhtiari et al. investigated the effect of upper respiratory tract care plans including raising the HOB to 45 degrees, removing subglottic discharge, mouth rinse using 2% Chlorhexidine, and measuring cuff pressure at 25 cmH_2O for 5 days. They reported that the rate of VAP in the intervention group decreased significantly (28). Chen et al. reported the reduction of VAP through the use of semi-sitting position (45 degrees) and draining subglottic secretions (29). Elorza Mateos et al. reported that

VAP significantly reduced after raising the HOB to 30 and 45 degrees and keeping the endotracheal tube cuff pressure at 20 mmHg (30). However, contradictory findings were reported. For instance, Grap et al. reported that raising the HOB to 30 degrees had no direct impact on the CPIS score (31). In the study of Keeley, no statistically significant difference was reported in VAP between the groups of the HOB elevation to 45 degrees and the control group. Also, the HOB elevation was accepted less by nurses for those patients who were under treatment by anesthetic drugs (32).

Patients in the ICU needed to change their position every 2 hours for the prevention of pressure ulcers (decubitus ulcer). They may undergo diagnostic procedures and therapeutic care and need to change their position. In this study, the patients received change of positions and therefore, the mean of the HOB elevation in the intervention group was lower than what was intended by the researcher.

Most of the time, the change of position was in the 45 degrees group, which could be related to maintaining their position in the intended slope. In line with this study, Van Nieuwenhoven et al. reported that the target HOB elevation to 45 degrees was not achieved in 85% of patients, due to the fact that they underwent the change of position more than patients in other positions. They suggested that the HOB elevation to 45 degrees could not be achieved in patients undergoing mechanical ventilation. The HOB elevation occurred mostly during weaning the patient from mechanical ventilation and feeding the patient. The greatest reduction in the HOB elevation occurred during the use of inotropic drugs and reduction of mean arterial pressure (28). Performing nursing procedures in critical conditions and carrying out nursing interventions in the lateral position hindered the elevation of the HOB. Other factors are a lack of patient comfort, fear of pressure ulcers, and insufficient information regarding raising the HOB for the prevention of VAP (33).

The results of this study showed that the strict implementation of prevention strategies, other than the HOB elevation (more than 30 degrees), helped to prevent the development of pressure ulcers, because none of the patients in the groups suffered from pressure ulcers, though some of them were overweight. However, the incidence of VAP was high, which emphasizes the importance of more strict approaches for the prevention of VAP.

In line with the findings of this study, Drakulovic et al. found that patients, even those in the supine position, did not suffer from pressure ulcers (34). Schallom et al. reported that no statistically significant difference was found in the rate of aspiration and reflux between the groups of patients with the HOB elevation to 30 and 45 degrees. Furthermore, none of them experienced pressure ulcers (14). However, Lippold et al. found that the pressure on the sacral area was increased when the HOB was elevated to 45 degrees ($P < 0.001$). The reverse trendelenburg position also led to less pressure on the sacral area ($P < 0.01$). A greater weight increases the pressure on the body and the use of low-air-loss mattresses reduces such pressure. As a result, the use of low-air-loss mattresses with the reverse trendelenburg position and HOB elevation to 30 to 45 degrees prevents skin damage in the sacral area (35).

Nurses need education regarding interventions for the prevention of VAP including: the elevation of HOB to more than 30 degrees and monitoring of impact of such interventions. Akin Korhan et al. stated that nurses in the ICU had insufficient knowledge regarding the prevention of VAP. Only 29.7% of them were informed of the importance of the semi-sitting position in the prevention of VAP (4). Hamishekar et al. declared that nurses did not have enough time for preventive care and received inadequate education about it (36). Therefore, a precise adjustment and permanent monitoring of the slope of bed using electronic devices can help maintaining the elevation of HOB to 30 - 45 degrees (more than 30 degrees) (37). Thus, there is also a need for the education of nurses working in the ICU regarding the necessity of the elevation of HOB and barriers to the provision of preventive interventions to VAP (38).

One of the strong points of the present study was that it was a randomized clinical trial. The limitation of this study was that the patients' positions were frequently changed for various reasons ranging from diagnostic procedures to therapeutic measures. Additionally, the researcher was not present in the ICUs during the night shifts. Therefore, it is possible that patients' positions were changed, but not documented in special forms and the patient's positions were not rectified after procedures. Furthermore, despite the education provided to nurses working in the ICUs, they did not sufficiently collaborate with maintaining the patients' position during the study. The shear stress as a risk factor for pressure ulcers was not measured in this study. However, our findings showed the effectiveness of the elevation of HOB in the reduction of VAP.

5.1. Conclusions

The elevation of HOB to 45 degrees helped prevent VAP compared to the elevation of HOB to 30 degrees and routine care. Therefore, it is suggested that nurses elevate HOB to 45 degrees (more than 30 degreess) among mechanically-ventilated patients admitted to the ICU.

There is a need for clinical guidelines for the prevention of VAP and infection control in the ICU. Moreover, job training as well as in-service education are required for nurses working in the ICU. Future studies are needed to be performed with larger sample sizes, effects of various

slopes of HOB elevation, and longer duration of intervention for investigating different factors affecting VAP.

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Footnotes

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