Original Article

EFFECT OF COMPREHENSIVE STRATEGIES FOR PREVENTION OF VENTILATOR-ASSOCIATED PNEUMONIA ON INCIDENCE OF THE DISEASE IN HOSPITALIZED PATIENTS IN INTENSIVE CARE UNITS

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ABSTRACT:

INTRODUCTION: Ventilator-associated pneumonia (VAP) is the second most common nosocomial infection and the commonest infection in intensive care units. VAP is associated with prolonged hospitalization, high mortality rate and treatment cost. The present study aimed to determine the impact of the implementing comprehensive strategies for prevention of ventilator-associated pneumonia on incidence of the disease in hospitalized patients in intensive care units.

METHODS: This was a randomized clinical trial on 86 ventilated patients in intensive care unit. The participants were divided into two groups: control and treatment. Treatment group received comprehensive strategies for prevention of ventilator-associated pneumonia. Control group received routine care. Data collection form consisted of demographic and clinical data as well as "Modified Clinical Pulmonary Infection Score (MCPIS) .The collected data was analyzed using SPSS 20 (descriptive statistical analysis and analysis of variance with repeated measurements).

RESULTS: The results of the study by the third day showed that mean score of MCPIS was not statistically significant in both groups ($P > 0.05$). Mean score of MCPIS was significantly lower in the treatment group than the control group on the fourth and fifth days of the project ($P < 0.05$). Trend of incidence of pneumonia was not significant in the treatment group over time ($P > 0.05$) but statistically significant in the control group ($P< 0.05$).

CONCLUSION: The results of implementation of comprehensive strategies for prevention of VAP decreased the incidence of ventilator-associated pneumonia in the patients hospitalized in intensive care unit. Therefore, it is recommended that infection control authorities and critical care nurses should use comprehensive prevention strategies in order to reduce the incidence of VAP.

KEYWORDS: ventilator-associated pneumonia, oral care, care suction system, intubation

INTRODUCTION:

VAP is known as infection in the lung parenchyma. No trace of pneumonia is detected at the beginning of intubation and respiratory support. Pneumonia is caused by microbial invasion into lower sterile airways and lung tissues.[1] This is because colonized bacterial access to the lower respiratory tract increases by 6-20 fold in intubated patients. This colony of bacteria is accumulated at the end of the pharynx[2]. Ventilator-associated pneumonia is a common and serious nosocomial infection, which is associated with many physiological complications and economic consequences. This infection increases hospitalization period by 7%-9%[3]. According to various reports, The mortality rate of VAP varies from 30% to 70%[4]. The most important risk factors for VAP include oral and pharyngeal pathogenic colonization, tracheal tube, non-compliance with hand hygiene by ICU staff, supine position during

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sleep, previous history of treatment with antibiotics, gastric tube and alkalinized gastric secretions[5]. Prevention of incidence of VAP and control of VAP risk factors are the best strategies to combat ventilator associated pneumonia[1]. Prevention of VAP requires different strategies including infection control precautions, physical position, intubation and mechanical ventilation, mouth and gastrointestinal tract, tracheal tube, airways pressure and cuff pressure, use of digestive and oral and pharyngeal antiseptics, use of probiotics or early intake of antibiotics[6]. New strategy for prevention of VAP lies in simultaneous use of the above strategies, which require individual, group and organizational cooperation and use of new materials and equipment. However, one or several strategies were used in most studies performed in this area. It seems that evidence on prevention and control of VAP is not convincing and enough. Therefore, the present study aimed to determine the effect of implementing comprehensive strategies for prevention of VAP on its incidence in the patients hospitalized in intensive care units.

METHODS:

This was a clinical trial on 86 mechanically ventilated patients in the ICU of Shahid Sadoughi Hospital, yazd, Iran. The sample size was calculated using the results of a study conducted by Vincent. [7] Based on the results of Vincent, and according to the type I error probability of 0.05 and a power of 0.7, the sample size was determined to be 43 patients for each group. Convenience sampling method was performed for enrolling the participants. Allocating the subjects to the treatment 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. Since implementation the strategies required broad changes and cooperation of all factors and employees, the project was carried out in two phases as the first quarter and the second quarter of 2016. First, the required data was collected from the control group. Then, necessary arrangements were made to implement the strategies including explanation of procedures to the authorities, staff training and development of check lists. Then, necessary data was collected from the treatment group. 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 admission 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' death 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. The required data was collected in two phases. In the first phase, demographic data (age, gender) and clinical data (smoking, the reason for hospitalization, history of disease) were collected through patients' records. In the second phase, Modified Clinical Pulmonary Infection Score was used for data collection. This is a standard scale in Iran and abroad (8).The scale(MCPIS) consisted of five criteria, namely body temperature, lung secretions, white blood cell count, Fio2-to-Po2 ratio per mmHg and chest radiography. Each item is scored from 0 to 2. Maximum score is 10. A score higher than 5 shows the incidence of ventilator-associated pneumonia. Routine care was provided to the patients in the control group including standard infection control precautions such as tracheal and oral suction, use of oral antiseptic and elevation of the head of the bed. It is noteworthy that routine care was not offered to all the patients regularly at all shifts. On the other hand, every ICU staff adopted a particular measure for prevention of VAP based on knowledge and experience. The treatment group received the comprehensive strategies listed in Table 1 in addition to routine care and strategies. All items in Table 1 were taught to practitioners, nurses and other staff. It was ensured that they had fully learnt and understood these strategies. The author monitored accurate implementation of the strategies during intervention. It was also noted that required instruments and equipment were prepared and were available to the staff for precise implementation of the strategies. If necessary, these prearrangements were explained to the authorities, so that they would

allow these measures. The above-mentioned scale was completed by the author and his expert assistant in order to detect ventilator-associated pneumonia. Accordingly, the patients were examined at 9 a.m. after intubation, on the third, the fourth and the fifth days after the intervention for detection of early pneumonia.

Table 1. comprehensive strategies for prevention of ventilator-associated pneumonia

Clinical	Standard precautions to control infection	Wearing gloves
		Use of disposable instruments (syringes, catheters, etc.)
		Use of disposable masks during contact with the patient
		Hand hygiene based on protocol, the items of hygienic washing of hands
		Environmental hygiene in the ICU
General	No frequent replacement of ventilation tube unless tracing noticeable secretion drainage in the tube (at least once a week)	
	Use of prophylaxis for deep vein thrombosis	
Body positioning	Half-sitting position – elevation of the head of the bed 30 to 45 degrees and monitoring the bed position twice a day	
Intubation and mechanical ventilation	Observing sterile techniques during tracheal intubation and replacement of tracheostomy tube	
	Oral intubation is superior to nasal intubation	
	Prevention of extubation by the patient and no re -intubation after extubation as much as possible	
	Proper daily examination of the patient for early extubation	
	Avoidance of prolonged use of tranquilizers	
	Oral care with 0.2% chlorhexidine	
Oral and gastro -intestinal tract	Assessment of suctioning for oral secretions in subglottic area before changing position of the patient	
	Correct positioning of nasogastric tube before each feeding	
	Avoidance of use of stomach tubes with a diameter larger than 14 Fr. Gz	
	Prophylaxis for peptic ulcers: intake of sucralfate	
Endotracheal tube	Use of an TaperGuard endotracheal tube with added line for suctioning subglottic secretions	
Airway pressure	Use of PEEP and avoidance of zero PEEP	
	Avoidance of routine suction (a specific program) of tracheal tube and use of standard protocols for suctioning tracheal tube	
	Closed-circular ventilator	
	Avoidance of frequent patient transfers	
cuff pressure	Maintaining and controlling cuff pressure regularly in the range of 20 to 30 cm of water	
Use of antiseptics and early antibiotics	Intake of selective oral and pharyngeal antiseptics	
	Early intake of antibiotics (prescription of single -dose prophylaxis antibiotic during early hours of intubation)	

The collected data was analyzed using SPSS 20, descriptive statistics (mean, standard deviation, and frequency percent) and inferential statistics (independent t-test, chi-square and Fisher's exact test (if needed), ANOVA with repeated measurements).

RESULTS:

It was noted that 96 eligible individuals participated in this study. The participants were divided into two groups as control (n=48) and treatment (n=48). Ten patients were excluded from the study according to sample loss criteria (five individual in the treatment and five individuals in the control). Finally, 43 patients remained in each group. Mean age of the participants in the treatment and control groups was respectively as 59.58 ± 19.65 and 61.65 ± 18.10. Independent t-test results showed no significant difference between the two groups in terms of age (P>0.05). Based on the results of chi-square and Fisher's exact test, no significant difference was observed between the two groups in terms of demographic and clinical characteristics (gender, reason for hospitalization, history of disease and history of smoking) (Table 2).

Mean comparison results showed no significant difference between the two groups in adjusted mean score of MCPIS before intervention.

However, a significant difference was observed between the two groups in adjusted mean score of MCPIS on the third, the fourth and the fifth days after the intervention (Table 3).

The trend of incidence of infection was studied in the two groups through comparison of adjusted mean score of MCPIS. ANOVA with repeated measurements showed a significant difference in both groups. LSD was used to compare the mean scores. Accordingly, adjusted mean score of pulmonary infection significantly increased in the control group on the third, the fourth and the fifth days (p<0.05). Moreover, adjusted mean score of pulmonary infection on the fifth day was significantly higher than on the third and the fourth days (P<0.05). Mean score of pulmonary infection on third, fourth and fifth days was statistically significantly higher than before intervention in the treatment group(P<0.05). However, no significant difference was found between mean scores of pulmonary infection on the third and the fourth days as well as on the fourth and the fifth days (P>0.05). However, a significant difference was observed between mean scores of pulmonary infection on the third and fifth days (P<0.05). (Table 4).

Table 2. Comparison of clinical and demographic characteristics of patients in two control and intervention groups

Variable	Title	Intervention group	Control group	Chi-square
		Number (percent)	Number (percent)	P
Gender	Male	26 (60.5)	27 (62.8)	0.825
	Female	17 (39.5)	16 (37.2)	
Reason for hospitalization	Internal	29 (67.4)	31 (72.1)	0.819
	Surgery	7 (16.3)	5 (11.6)	
	Internal - surgery	7 (16.3)	7 (16.3)	
History of hospitalization	Respiratory	30 (69.8)	29 (67.4)	0.966
	Non-respiratory	9 (20.9)	10 (23.3)	
	No disease	4 (9.3)	4 (9.3)	
History of smoking	Positive	5 (11.6)	7 (16.3)	0.534
	Negative	38 (88.4)	36 (83.7)	

Table 3. Comparison of adjusted mean scores of pulmonary infection before and after the study between the control and intervention groups

Time	Intervention group	Control group	Independent t - test	P
Before intervention	1.75 ± 1.04	1.79 ± 0.67	0.493	0.623
On the third day	2.91 ± 0.97	3.47 ± 1.09	2.492	0.015
On the fourth day	3.00 ± 1.13	4.07 ± 1.35	3.975	0.001
On the fifth day	3.10 ± 1.02	5.19 ± 1.33	7.903	0.001
ANOVA with repeated measurements	F = 80.978 p-value < 0.001	P < 0.001 F = 212.17		

Table 4. Comparison of incidence of VAP in the control and intervention groups based on day

LSD		
Intervention days	P in the treatment group	P in the control group
Before intervention and on the third day	< 0.001	< 0.001
Before intervention and on the fourth day	< 0.001	< 0.001
Before intervention and on the fifth day	< 0.001	< 0.001
On the third and the fourth days	0.103	< 0.001
On the third and the fifth days	0.001	< 0.001
On the fourth and the fifth days	0.33	< 0.001

DISCUSSION:

In this study, 86 mechanically ventilated patients were compared by either use of VAP prevention strategies or routine strategies. Mean comparison results showed no significant difference between the two groups in adjusted mean scores of pulmonary infection on the third, the fourth and the fifth days. Furthermore, this score was considerably lower in the treatment group compared to the control group. It should be noted that a score higher than 5 was recorded on the fifth day in the control group, which represented early pneumonia. On the other hand, no trace of early pneumonia was detected in the intervention group. This suggests that simultaneous implementation of VAP prevention strategies slightly increased adjusted mean score of pulmonary infection in the patients compared to implementation of several VAP prevention strategies [9,10,11] reported that subglottic secretion suctioning reduced the incidence of ventilator-associated pneumonia and decreased mortality rates among the patients.[12] It showed that intake of single-dose antibiotics within 4 hours after intubation decreased the risk of early VAP. [13] Also reported the effect of elevation of the head of the bed on the incidence of VAP. The risk of VAP is higher in the patients with angle of head of the bed less than 30 degrees compared to other patients[14], showed that adjusting cuff pressure to minimum pressure by imposing the least possible pressure on walls of the tracheal tube can prevent aspiration of secretions in the airways and consequently prevent incidence of VAP.[15] Also showed that short training

programs for hand washing as a VAP preventive strategy reduces the incidence of VAP in an effective manner. The results of the study showed the protective effect of chlorhexidine mouthwash on oral hygiene and prevention of VAP in critical patients.[16] The results showed a significant difference in trend of increase in adjusted mean scores of pulmonary infection. Thus, significant differences were observed in adjusted mean scores of pulmonary infection before intervention and the third day, before intervention and the fourth day, before intervention and the fifth day. Adjusted mean scores of pulmonary infection were also higher in the third day compared to before intervention, in the fourth day compared to before intervention, in the fifth day compared to before intervention. It seems that strictly controlled intubation and ventilation are also associated with the risk of pneumonia. Therefore, this procedure (intubation and ventilation) should not be selected (opted) as far as possible. The results of the study showed that VAP was detected in 19% of mechanically ventilated patients within 6 days after intubation[17]. Pulmonary infection score decreased on the third and the fourth days as well as on the fourth and the fifth days. No difference was found between the scores in these days. However, statistically significant differences were found between adjusted mean scores of pulmonary infection in different days in the control group. This represents a noticeable increase in mean scores of pulmonary infection. Therefore, it seems that VAP prevention strategies have a considerable effect on adjusted mean scores of pulmonary infection, especially after a long period. Thereby, these strategies are not only effective in early pneumonia but also late-onset pneumonia.

CONCLUSION:

The results of the present study showed that implementation of comprehensive strategies for prevention of VAP (e.g. clinical, controlling and general measures) led to a noticeable decrease in incidence of VAP. Particularly, the trend of incidence of VAP was decreased. Therefore, it is recommended that all authorities and nurses in ICU should use comprehensive strategies for prevention of VAP to control and prevent VAP. However, further studies are required to completely control and prevent VAP. Given available evidence, it is suggested that further studies be conducted on the effect of comprehensive strategies for prevention of late-onset VAP. A limitation of this study was exclusion of the project to one center. It is recommended that the effect of implementation of these strategies for prevention of VAP on incidence of early VAP be examined in other centers.

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