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Training Healthcare Staff on Ventilator-Associated Pneumonia (VAP) Prevention Bundle and Its Effects on VAP

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ABSTRACT

Ventilator-associated pneumonia (VAP) is a nosocomial infection that can develop in patients receiving mechanical ventilator (MV) support. VAP has a high mortality rate and cost due to prolonged hospitalisation. Some procedures have shown that VAP can be prevented. However, the incidence of VAP is still high in Turkey. In this study, we aim to investigate how increased compliance with VAP prevention bundle training for health personnel affects the incidence of VAP, the onset day of VAP, the duration of mechanical ventilation, and mortality rates.

This prospective case control study was started after obtaining permission from the Van Yuzuncu Yil University (VYYU) Medicine School Ethics Committee. It was conducted between November 2017 and June 2018 at the Anesthesiology and Reanimation Intensive Care Unit (ICU) of the Dursun Odabaş Medical Center, VYYU Medicine School. In this study, the study group (VAP prevention bundle group after healthcare staff training) included 68 patients who received MV support. The control group consisted of 100 patients who received the VAP prevention bundle between January 2016 and June 2017 in the anaesthesia ICU. The Centers for Disease Control and Prevention (CDC) criteria were used for the diagnosis of VAP. In both groups, compliance with the Prevention Bundle, the incidence of VAP, the onset day of VAP, the duration of mechanical ventilation, the day of tracheostomy operation and mortality rates were recorded. Patient groups were compared statistically.

The demographic data, diagnosis and cultured microorganisms in VAP patients were similar and there was no statistically significant difference. The effect of four parameters [Endotracheal tube with subglottic secretion drainage (SSD-ETT), 0.12% chlorhexidine oral care, peptic ulcer prophylaxis and deep venous thrombosis (DVT) prophylaxis] that were included in the VAP Prevention bundle could not be evaluated separately because of the mean fit. The mean fit in holding the bed head position at an angle of 30°–45° was 100% in the VAP Prevention bundle group, while in the control group the average was 90.67% (85-100%). The relationship between this and the development of VAP was statistically significant (p=0.036). ETT cuff pressure of 20–25 cm H2O was maintained at 97.96% in the VAP Prevention Bundle group and at 93.13% in the control group. The difference between the groups according to the accordance to the ETT cuff pressure was statistically significant (p=0.01). In our study, VAP was detected in 12 patients (17.6%) in the study group and 9 patients (9%) in the control group. There was no statistically significant difference between the groups in terms of VAP or the duration of mechanical ventilation support (30.29 ± 24.5/26.11±15.47). No early development of was seen in either group (first four days after MV support). It was determined that all VAP attacks developed after the fifth day of MV support. For 1000 ventilator days, onset of VAP was 13.1 days in the VAP prevention bundle group and 4.29 days in the control group, which was not statistically significant (p = 0.96). Although the mean number of days of VAP-developing groups in relation to MV was 44.83 ± 30.845/82.22 ± 55.432, it was not statistically significant. In the VAP prevention bundle group, the mean day of application of tracheostomy was 7.09 ± 7.12 while it was 16.67 ± 9.11 in the control group; this difference between the groups was statistically significant. Although the mortality rate was increased in patients with VAP, it was not statistically significant. However, mortality rates were significantly lower in patients without VAP as compared to the control group (p<0.05).

Implementation of the VAP prevention bundle group did not decrease the incidence of VAP in our clinic. It was found that strict compliance to the all parameters of the prevention bundle didn't reduce the VAP incidence in ICUs but it was prolonged the onset time of VAP. But the carrying out the VAP prevention bundle to the patients with mechanical ventilatory support reduced the mortality rates. We think that the present VAP prevention bundle should be revised in the way of use of stress ulcer prophylaxis.

Key Words: Ventilator-associated pneumonia (VAP), VAP prevention bundle, intensive care unit, mechanical ventilation

Introduction

Ventilator-Associated Pneumonia (VAP) is defined as a nosocomial infection which develops within 48–72 hours after receiving mechanical ventilator (MV) support (1). The incidence of VAP varies among countries and is between 8.7-38.6% in Turkey. Although there were differences between hospitals

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and intensive care units, the mortality rate was found to be 20-75% for patients with VAP (2).

There is an increasing focus on VAP due to the high mortality rate, cost and length of hospital stay. Many studies have been carried out on VAP prevention and identification of its parameters. Individual application of these parameters has not reduced hospital infections to a desired level, but by applying some of these parameters in a bundle approach, the desired targets were reached or even reduced to zero (3).

The important parameters of the implementation of the prevention bundle according to the Institute for Healthcare Improvement (IHI) are: a 30°-45° elevation of the head of the bed head of the bed; deep vein thrombosis prophylaxis; peptic ulcer prophylaxis; a daily "sedation vacation; chlorhexidine oral care; and aspiration of subglottic secretions (2). Apart from these measures, the European Working Group (EWG), the American Thoracic Society (ATS) and the Infectious Diseases Society of America (IDSA) guidelines of keeping the cuff pressure 20–30 cm H_2O were reported to be protective in the prevention of the development of VAP (4).

In this study, we aim to investigate the effects of increasing compliance with the VAP prevention bundle in patients who received ventilator support in an anaesthesiology ICU on VAP incidence, the onset time (as day) of VAP, duration of mechanical ventilation, the day of tracheostomy operation and mortality rates.

Materials and Methods

Our study was a prospective case control study and it was started after obtaining the consent of the Ethics Committee of Van Yuzuncu Yil University (VYYU) Medicine School. This study was performed on patients who were followed-up between November 2017 and June 2018 in the Anesthesiology and Reanimation Intensive Care Unit (ICU) of the Dursun Odabaş Medical Center, VYYU Medicine School. Within this period, 68 patients in the intensive care unit on mechanical ventilator support were included in our study. The control group consisted of patients in the ICU between January 2016 and June 2017. In our study, CDC criteria were used for the diagnosis of VAP. Patients in the ICU who were over 18 years of age and had at least 48 hours of mechanical ventilation were included in the study. We excluded: those who did not agree to participate in the study or whose relatives did not give consent (for unconscious or severely ill patients); patients under 18 years of age; the patients who were intubated in other clinics or the patients were on mechanical ventilation support less than 48 hours; patients who were immunosuppressive or who had a malignancy; or those who were diagnosed with pneumonia in the prior 48 hours.

During the study period, training was given to all nurses, staff and doctors working in the ICU every month. In this study, was used the prevention package of the IHI (4). The training content included the prevention bundle measures, the mode of administration, the ways in which VAP could develop, the cost and the effects on the mortality and morbidity of the patients and perhaps most importantly, training seminars on how to prevent the development of VAP.

Statistical Analysis: Descriptive statistics for continuous variables were expressed as mean, standard deviation, minimum and maximum values, while categorical variables are expressed in numbers and percentages. Student t test was used to compare the group means for the continuous variables. The chi-square test was used to determine the relationship between groups and categorical variables. The statistical significance level was taken as 5% in the calculations and the Statistical Package for the Social Sciences (SPSS, version 25) statistical package program was used for the calculations.

Results

The demographic data of the patient profile included in the study were similar in terms of the microorganisms in the culture of patients with VAP and their diagnoses (Table 1, $p>0.05$).

As the average fit of the four parameters in our VAP prevention bundle, SSD-ETT (100%), 0.12% chlorhexidine oral care (100%), peptic ulcer prophylaxis (100%) and DVT prophylaxis (100%) was fully achieved, these parameters could not be evaluated individually.

We found that the compliance with keeping the head at an angle of 30°-45° was 100% in our study group. Compliance with this parameter was found to be 90.67% (85-100%) in patients with VAP in the control group. There was a statistically significant difference between the groups in terms of VAP development by holding the head of the bed at 30°-45° ($p=0.036$).

Among the VAP prevention bundle parameters, compliance with keeping the ETT cuff pressure 20-25 cm H_2O was 97.96% in the VAP prevention bundle group and 93.13% in the control group. A statistically significant difference was found between VAP development and keeping the ETT cuff pressure 20-25 cm H_2O ($p=0.01$).

The VAP prevention bundle group and control group

Table 1. Demographic data of the patients, the systems including patient diagnosis and the microorganisms reproduced in the culture of patients with VAP

	Variables	VAP* Prevention Bundle Group	Conrol Group
The average age		57.9	57.75
Cinsiyet (n=168)	Male (55%)	42	52
	Woman (45%)	26	48
Diagnosis Systems	Central Nervous System	18	23
	Respiratory System	16	17
	Cardiovascular System	11	15
	Gastrointestinal System	2	8
	Travma	19	31
	Urogenital System	1	1
	Other	1	3
Diagnosed microorganisms	Klebsiella	6	5
	Acinetobacter	2	3
	Pseudomonas	4	1
	Heamophilus Influenzae	1	0
	Escherichia coli	0	1

*VAP: ventilator-associated pneumonia

Table 2. Adaptation rates to the Prevention Bundle in VAP group

		n	Mean	SD	Min	Max
MV days count	VAP PB Group	12	44.83	30.845	9	116
	Control Group	9	82.22	55.432	16	180
	Total	21	60.86	45.955	9	180
Tracheotomy opening day	VAP PB Group	11	7.09	7.12	0	21
	Control Group	9	16.67	9.11	0	30
	Total	20	11.4	9.247	0	30
VAP development day	VAP PB Group	12	30.29	24.577	8	94
	Control Group	9	26.11	15.479	12	65
	Total	21	28.5	20.798	8	94

VAP: ventilator-associated pneumonia, MV: mechanical ventilation, SD: Std. Deviation

patients in the intensive care unit; days on ventilator, number of patient with VAP, VAP attacks and VAP development speeds are given in Table 3.

There was no early VAP development in both groups (in the first four days on MV support). All VAP attacks developed five days after MV support. The number of patients with VAP in the VAP prevention bundle group was 12 and in the control group was 9. In terms of VAP speeds, the onset of VAP was found to be 13.1 days in the VAP prevention bundle group and 4.29 in the control group per 1000 ventilator days. This difference was not statistically significant (p=0.96).

Table 3. Number of ventilator days, number of VAP, VAP attacks, VAP rates of both groups

		Grand Total (n=168)	VAP Prevention Bundle Group n=68	Control Group n=100	*p* value
		Mean ± SD	Mean ± SD	Mean ± SD	
Monitored Ventilator Day		[a]3267 ± 334	[b]991 ±210	[ab]2276 ± 435	0.050[#]
VAP rate on 1000 Ventilator Days		[ab]7.04 ± 1.32	[a]13.11 ± 2.58	[b]4.39 ± 1.11	0.045[#]
		n (%)	n (%)	n (%)	
Number of Patients with VAP* n (%)	Yes	21 (12.5)	12 (17.6)	9 (9)	0.251[ϕ]
	No	147 (87.5)	56 (82.4)	91 (91)	
Number of Attacks n** (%)	Yes	23 (13.69)	13 (19.11)	10 (10)	0.106[ϕ]
	No	145(86.31)	55 (80.89)	90 (90)	
Late Developing VAP (%)	Yes	23 (13.69)	13 (19.11)	10 (10)	0.106[ϕ]
	No	145(86.31)	55 (80.89)	90 (90)	

* First attacks of patients with multiple VAP attacks were taken

** All attacks of patients with multiple VAP attacks were taken

VAP prevention bundle: Ventilator-associated pneumonia prevention bundle

#: Student t test

ϕ: Chi-square test

When we compared the 12 VAP cases and 9 control group cases in terms of MV duration, no statistical significance was found (44.83±30.845/82.22±55.432).

The evaluation of the groups in terms of the day of tracheostomy operation is given in Table 4.

The mean day of application the tracheostomy procedure was 7.09±7.12 in the VAP prevention bundle group and 16.67±9.11 in the control group, which was statistically significant.

When the patients with VAP in two groups were compared in terms of mortality rates, although there was a decrease in the rate of patients mortality in VAP prevention bundle group, but it wasn't statistically significant. In other hand when the patients without VAP were compared in terms of mortality rates there was a significant decrease in VAP prevention bundle group.

Discussion

VAP is one of the most frequent hospital infections (HI) and is most commonly seen in intensive care units although it can be seen in other units of hospitals. VAP is defined as nosocomial infection that develops in the patient with mechanical ventilation support within 48-72 hours after the hospital admission without prior pneumonia diagnosis (1). In the last 20 years, many studies have been done for prevention of HIs and have yielded successful results. In the ICU, scientifically proven parameters are applied in order to prevent VAP, which is an infection with high mortality and cost, prolonging hospitalisation. These parameters (3-6 in number), together are called the VAP prevention bundle (bundle approach) (2). Complying with the VAP prevention bundle is an all or none approach. If any of the parameters contained in the prevention bundle is not followed, then the others parameters are also taken as not complied with. Today, the VAP rate is considered to be one of the most important criteria for centres and ICUs. Hospital managements and other authorities form prevention bundles containing different parameters suitable for their units in order to improve the quality of ICUs. Some studies have shown that VAP rates were reduced to 1-4 VAP attacks for 1000 ventilator days, even in some studies VAP rates came to zero level for a period of time with VAP prevention bundle (5).

When the VAP data of the surgical and medical ICUs of 36 developing countries including Turkey were evaluated by the International Nosocomial Infection Control Association, the mean VAP rate was found to be 18.4 (17.9-18.8) for 1000 ventilator days (6). In our study, when the VAP rate in our clinic was compared with the period before VAP prevention bundle application, the rate decreased in accordance with the literature [17.6% (n=12)]. However, there was no decrease in the control group VAP ratio [9% (n=9)] as determined by the date of the application of the bundle.

Mechanical ventilation is one of the most important risk factors for the development of VAP. In patients who underwent MV, it was necessary to terminate MV as soon as possible (2). In order to terminate MV application, it is recommended that the daily sedation of patients should be interrupted and weaning

Table 4. Descriptive statistics and comparison results for Tracheostomy Opening Day

	VAP Yes (n =7)	VAP No (n =7)	
	Mean ± SD	Mean ± SD	p value #
VAP Prevention Bundle Group n=14	11.14 ± 3.42	12.14 ± 4.78	0.173
Total	11.64 ± 3.58		
Control Group n=22	VAP Yes (n =8)	VAP No (n =14)	
	18.75 ± 6.96	23.64 ± 9.92	0.063
Total	21.86 ± 7.81		
General Total n=36	17.88 ± 5.67		

: Student t test

(separation) protocols should be used (7). In our study, mean compliance to the implementation of the sedation break and the weaning protocols in the VAP prevention bundle was the least compatible parameter at 64%. The reason for this is that sedation was applied to 34 patients in the ICU and the patient profiles were not suitable for applying the weaning criteria.

The most critical step in VAP development in the ICU is the passage of contaminated secretions in the oropharynx into the lower respiratory tract by micro-aspiration. The ETT cuff pressure is very important. If the cuff pressure is elevated, ciliary dysfunction of mucosal cells, disruption of mucosal blood flow, and eventually ulceration, bleeding, tracheoesophageal fistula or tracheal stenosis may occur. If the cuff pressure of the ETT is low, secretions may pass to the lower respiratory tract by micro-aspiration, where they can cause infection. Regular cuff pressure monitoring is recommended to keep the ETT cuff pressure 20-30 cm H_2O according to the European Working Group (EWG), the American Thoracic Society (ATS) and the Infectious Diseases Society of America (IDSA) guidelines. The ETT cuff pressure measurement can be done in two ways: The first is to measure the cuff pressure with a manual manometer every 4 hours. The second, recommended route is to use a digital cuff meter to keep the ETT cuff pressure at a constant desired value in the 20–30 cm H_2O range. ETTs have been reported to be an effective parameter in preventing the development of VAP (7). The head pressure measurement of the ETT was carried out regularly with a manual manometer for four hours. However, the disadvantage is that the pressure on the cuff by the manual manometer can lead to micro-aspirations as a result of pressure changes that may occur during both measurement and intervening intervals. In order to reduce micro-aspirations, it may be beneficial to aspirate subglottic secretions before measuring the cuff pressure (8). The disadvantage of measuring ETT cuff pressure with digital devices is the high cost of this method according to the manual measurement. In our study, ETT cuff pressure was measured regularly with a manual manometer every four hours. Although the compliance to the cuff pressure control was significantly increased in the VAP prevention bundle group compared to the control group, VAP ratio wasn't reduced. This might be caused because we didn't use the digital devices.

In our study, VAP did not develop within the first four days after MV support in both groups. In the VAP prevention bundle group, VAP developed on the 30th day after MV support. After the application of the VAP prevention bundle, VAP development was found to be prolonged by an average of 4 days in the control group. We believe that this extension of the VAP development time is the result of our application of the VAP prevention bundle (9).

In our study, the mean day of application of tracheostomy was 11.4±9.24. In other words, early tracheostomy was performed on our patients. In addition, the general compliance was found to be 100% in the study group in keeping the head of the beds at 30°–45°. Our VAP prevention bundle compliance was: SSD-ETT (100%), 0.12% chlorhexidine oral care (100%), peptic ulcer prophylaxis (100%), DVT prophylaxis (100%), and sedation vacation (75%) (It was shown in table 2). On the other hand recent studies suggest that routine stress ulcer prophylaxis may increase the incidence of VAP (10,11).

The overall mortality rate in the ICU in our study was 61.3% (n=103), with mortality rates of 48,5% (n=33) patients in the VAP prevention bundle group and 70% patients in control group (n=70). But the difference between the groups weren't significant statistically (p=0,96) (Table 2). In our study, the mortality rate in patients with VAP was found to be consistent with the literature.

All personnel were given the necessary training before the start of our study. On average, the training was repeated once a month. In order to ensure behavioural change in the health personnel, regular trainings will need to be carried out, and for the desired behaviour changes to be permanent, long-term monitoring and providing feedback is necessary.

Limitations of our study; our study was applied for a short period of time, and changes in the health personnel in the ICU, insufficient education and a lack of feedback may have affected the results. The other limiting factor to our study was the routine stress ulcer prophylaxis existence in the bundle.

It was found that the VAP prevention bundle didn't reduce the VAP incidence in ICUs but it was prolonged the onset time of VAP. But the carrying out the VAP prevention bundle to the patients with mechanical ventilatory support reduced the mortality rates. We think that the present VAP prevention bundle should be revised especially in the way of use of stress ulcer prophylaxis.

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Conflicts of Interest Disclosure: The authors declare that they have no conflicts of interest.

References

1. Torres A, Ferrer M, Badia JR. Treatment guidelines and outcomes of hospital-acquired and ventilator-associated pneumonia. Clin Infect Dis 2010; 51: 48-53.
2. Dizbay M. Yoğun Bakımda Önlem Paketleri: Ventilatörle ilişkili Pnömoni. Hastane İnfeksiyonları Dergisi 2012; 16: 167-182.
3. Jarvis WR. The Lowbury Lecture. The United States approach to strategies in the battle against healthcare-associated infections, 2006: transitioning from bench marking to zero tolerance and clinician accountability. J Hosp Infect 2007; 65: 3-9.
4. Lorente L, Blot S, Rello J. Evidence on measures for the prevention of ventilator-associated pneumonia. Eur Respir J 2007; 30: 1193-1207.
5. Coffin SE, Klompas M, Classen D, et al. Strategies to prevent ventilator-associated pneumonia in acute care hospitals. Infect Control Hosp Epidemiol 2008; 29: 31-40.
6. Rosenthal VD, Bijie H, Maki DG, et al. International Nosocomial Infection Control Consortium (INICC) report, data summary of 36 countries, for 2004-2009 2012; 40: 396-407.
7. American Thoracic S, Infectious Diseases Society of A. Guidelines for the management of adults with hospital-acquired, ventilator-associated, and healthcare-associated pneumonia. Am J Respir Crit Care Med 2005; 171: 388-416.
8. Bouza E, Pérez MJ, Munoz P, Rincón C, Barrio JM, Hortal JJC. Continuous aspiration of subglottic secretions in the prevention of ventilator-associated pneumonia in the postoperative period of major heart surgery 2008; 134: 938-946.
9. Bird D, Zambuto A, O'Donnell C, et al. Adherence to ventilator-associated pneumonia bundle and incidence of ventilator-associated pneumonia in the surgical intensive care unit. Arch Surg 2010; 145: 465-470.
10. Bonvicini D, Labate D, Benacchio L, Olivieri A, Pizzirani E. Type of stress-ulcer prophylaxis and incidence of ventilator-associated pneumonia. Intensive Care Med Exp 2016; 4: 251-607.
11. Alhazzani, Waleed, Belley-Cote E, et al. "Efficacy and safety of stress ulcer prophylaxis in critically ill patients: a network meta-analysis of randomized trials. Intensive Care Med 2018; 44: 1-11.