Original Article

Comparative Study of the Effect of Three Oral Care Protocols on Ventilator-Associated Pneumonia in Critically Ill Patients: A Clinical Trial

Somayeh Haghighat[1], Hossein Mahjobipoor[2], Samira Ghasemi Gavarti[3]

[1]MSc in Critical Care Nursing, Department of Critical Care Nursing, Nursing and Midwifery Care Research Center, Faculty of Nursing and Midwifery, Isfahan University of Medical Sciences, [2]Assistant Professor of Critical Care Medicine, Department of Anesthesiology, School of Medicine, Anesthesiology and Critical Care Research Center, Isfahan University of Medical Sciences, [3]Department of Critical Care Nursing, Student Research Center, Faculty of Nursing and Midwifery, Isfahan University of Medical Sciences, Isfahan, Iran

Abstract

Background: Oral care plays a significant role in reducing the incidence of Ventilator-Associated Pneumonia (VAP) in Intensive Care Units (ICUs). The aim of this study was to investigate the effect of three oral care protocols on the incidence of VAP in Mechanically-Ventilated (MV) patients hospitalized in ICUs. **Materials and Methods:** This parallel randomized clinical trial was performed in 2019 on 71 MV adult patients with endotracheal intubation hospitalized in ICUs. The patients were divided into three groups: a 7-day oral care by using swab (group 1), two-times-brushing group (group 2), and four-times-brushing group (group 3) by using chlorhexidine. The data related to the incidence of pneumonia were analyzed during several days using Chi-square and ANOVA tests. **Results:** The incidence of pneumonia on the fourth day of the intervention in the first group (35.00%) was significantly higher than that of the two intervention groups (10.00%) ($\chi^2 = 5.86$, df = 2, p = 0.03)). The mean score of modified clinical pulmonary infection in the third group was significantly lower seven days after the intervention than before the intervention ($p = 0.04$) and the fourth day of intervention ($p = 0.003$). In the first group, this score was significantly higher in the fourth day of the intervention than the seventh day ($p = 0.003$). **Conclusions:** Based on the results, the oral care protocol, including four-times-brushing, reduced the risk of VAP more than two times brushing. Therefore, the use of this protocol is recommended to provide a minimum level of oral care and reduce the risk of VAP in MV patients.

Keywords: *Intensive care units, mouth, nursing care, pneumonia, ventilator-associated*

Introduction

Caused by infectious agents, nosocomial pneumonia is an infection of the lung parenchyma which is not present at the time of admission to the hospital and during the incubation period, but occurs at least 48 hours after being hospitalized.[1] Need for mechanical ventilation and intubation increases the risk of pneumonia by 3%–21%.[2] This type of infection is called Ventilator-Associated Pneumonia (VAP)[3] that as a prevalent and serious problem in hospitals may increase mortality rate, the duration of mechanical ventilation, and the time of hospitalization, and make it difficult to disconnect the patient from the ventilator.[4] In Mechanically-Ventilated (MV) patients, artificial airways can eliminate natural protective mechanisms such as coughing and mucosal reflexes.[5] Twenty-four hours after the onset of mechanical ventilation, the lower airways are contaminated because of advanced colonization.[6] The colonization of pathogens in the oropharynx and the micro-aspiration of lower respiratory tract are mentioned as two important factors in the incidence of VAP.[7]

Various measures have been taken to prevent VAP in patients hospitalized in Intensive Care Units (ICUs). These measures, the most important of which is oral care, are known as the VAP bundle.[8] In oral care, brushing and using swab are known as mechanical methods. Toothbrush has an important role in controlling the accumulation of dental plaque, maintaining oral mucosal integrity, and decreasing the inflammation of mouth and gums. Another method of oral care is the use of antiseptic mouthwashes as a chemical intervention.[9] Mouthwashes reduce the risk of VAP by reducing the number of microorganisms and, consequently, reducing transmission and colonization in the lungs.[9,10] Among mouthwashes, chlorhexidine solution is an

Address for correspondence:
Samira Ghasemi Gavarti, MSc in Critical Care Nursing, Faculty of Nursing and Midwifery, Isfahan University of Medical Sciences, Isfahan, Iran.
E-mail: s.ghasemi@nm.mui.ac.ir

Access this article online

Website: www.ijnmrjournal.net

DOI: 10.4103/ijnmr.ijnmr_243_20

Quick Response Code:

How to cite this article: Haghighat S, Mahjobipoor H, Gavarti SG. Comparative study of the effect of three oral care protocols on ventilator-associated pneumonia in critically ill patients: A clinical trial. Iran J Nurs Midwifery Res 2022;27:99-105.

Submitted: 26-Jul-2020. **Revised:** 26-Aug-2020.
Accepted: 20-Oct-2021. **Published:** 14-Mar-2022.

effective solution against gram-positive and gram-negative bacteria, and anaerobic and aerobic species of fungi and, that is why, disinfection of oropharynx through using it has become a standard oral care during the last decade.[11]

Many studies have examined a method or a combination of oral care methods for the MV patients.[2,3,7] The results of a multicenter research by Ames *et al*.,[12] as well as the study of de Lacerda Vidal *et al*.,[2] have confirmed the effect of brushing on reducing the prevalence of VAP in ICUs. However, a number of studies have pointed to the ineffectiveness of brushing on VAP reduction in MV patients hospitalized in ICUs.[13,14] In oral care protocols, brushing with chlorhexidine is considered to be a part of the relevant bundle that makes it difficult to detect the contribution of brushing to the prevention of VAP.[15] Moreover, the effect of brushing times on VAP prevention has not been evaluated in the studies with positive results, and researchers have suggested different number of times (from once every hour to once every 12 hours) for oral care.[9] Given the different and contradictory results of oral care protocols about the effects of chlorhexidine mouthwash with and without tooth brushing and considering the lack of a global agreed standard about the oral care of MV patients, as well as the importance of oral care in preventing VAP in these patients, further studies seem to be necessary. The aim of this study was to compare the effect of three oral care protocols on the incidence of VAP in MV patients hospitalized in ICUs.

Materials and Methods

This study is a three-group clinical trial conducted from October 2019 to February 2020 in Iran. A seven-day intervention was performed and its effect was examined in several stages before, during, and after the intervention. The study received the registration code for clinical practice IRCT20191012045066N1. Seventy-one 18–65 years-old MV patients with orotracheal tube who were hospitalized in ICUs of educational hospitals affiliated to Isfahan University of Medical Sciences entered the study using the convenience sampling method.

According to inclusion criteria these patients had teeth, no inflammation of the mucosa or severe oral trauma, no chronic diseases and immune and coagulation disorders, and a maximum of 24 hours had passed since they were intubated and had no reintubation.[11,16,17] The patients with pre-intervention extubation and tracheostomy, with clear aspiration, less than 4000 platelets and INR >2, who were diagnosed with pneumonia within 48 hours after the start of mechanical ventilation and were discharged or transferred before the seventh day of the intervention, were excluded from the study.[2,16-18]

The sample size, with 95.00% confidence coefficient and 80.00% test power, was obtained to be 20 patients in each group that, given the probable 10.00% drop in the samples, was considered to be 22 patients for each group. The patients were allocated randomly into three groups by the researcher and using minimization software. In order to balance the samples, the age, gender, diagnosis, and endotracheal tube size were defined in the minimization software in order to allocate the groups. At the same time, the probability of 0.80 was determined for random allocation of samples in three groups. Given the drop of the samples, sampling continued until the number of samples reached 20 subjects in each group.

Oral care intervention was performed in three different shifts from the first day of the patient's intubation to the seventh day by the researcher and a number of nurses who underwent a face-to-face and practical training by the researcher. At each intervention, the patients underwent oral care for five minutes after being placed in a lateral or semi-sitting position.[3] If necessary, the patients' mouths were suctioned and every 4 hours, their mouths were moistened using Veramin oral moisturizing gel and the lips were lubricated by Vaseline.[9,19]

Oral care was performed for the first group in such a way that the surfaces of teeth, gums, tongue and inner wall of the mouth, as well as the surface of that part of the tracheal tube which was inside the mouth, were cleaned every 12 hours by a movement from the back of the mouth toward the lips using a swab soaked in 0.20% chlorhexidine mouthwash solution (routine care). If there were some discharges on the mentioned surfaces, dry swabs would be used first to remove them. In the second group, oral care was performed every 12 hours by using a toothbrush impregnated with 0.20% chlorhexidine, and in the third group, oral care was performed every 6 hours, two times through using a toothbrush impregnated with 0.20% chlorhexidine solution and two times using a toothbrush impregnated with normal saline. In all three groups, the patients' mouth was suctioned before and after oral care if needed. Children's soft toothbrush was used for brushing the teeth through a forward-back vibration movement, and all surfaces inside the mouth and the surface of the tracheal tube were brushed through a back-forward movement. This was done based on Modified Bass technique approved by dental articles and oral care of the MV patients.[16,20]

Age, gender, marital status, level of education, date of admission, cause of hospitalization in ICU, diagnosis, medication (antibiotics, anticholinergic, narcotics, diuretics), history of previous illnesses, nutritional status, the platelet count, tracheal tube number, and SOFA and APACHEII scores were recorded as the baseline information. The incidence of pneumonia was investigated before, four days after, and seven days after the intervention using Modified Clinical Pneumonia Infection Score (MCPIS).

Given the different oral care methods, blindness was not possible during the study. The checklist information was collected by the researcher and interpreted by the intensivist. A score equal to and greater than 5 was indicative of VAP. The mentioned tool has been used

in many studies.[17,21] The content validity of the tool has been confirmed in a study in Iran through the opinion of a relevant expert and its reliability has been checked using Pearson correlation coefficient of 0.92%.[22]

Data analysis was performed using SPSS software, version 19 (An IBM Company). To compare the demographic characteristics of the three groups, Kruskal–Wallis one-way ANOVA and Chi-square were used. One-way ANOVA, Chi-square, repeated measures ANOVA, Cochran test, and LSD Post-Hoc were used to compare the mean and frequency distribution of data of the three groups in the measurement times. Data were represented as mean (SD) or *n* (%) where applicable. $p < 0.05$ was considered statistically significant and was reported by two fraction digits.

Ethical considerations

This study was approved by Ethics Committee of Isfahan University of Medical Sciences (Ethical code IR.MUI. RESEARCH.REC.1398.333). The aim of the study was explained to the patients or their legal guardian before interventions and they were assured about confidentiality and anonymity of their information. Verbal and written informed consent was obtained from patients or their legal guardian who accepted to participate in the study. Moreover, all of the participants were free to withdraw from the study whenever they/their legal guardian wanted.

Results

During a five-month study, a total number of 71 eligible patients, who were randomly allocated to three groups, underwent oral care and were examined for the incidence of VAP. Eleven patients were excluded from the study before the end of the intervention because of the removal of the tracheal tube, death, and transfer to other medical centers for receiving medical services. Finally, 60 patients (20 in each group) took part in the study [Picture 1].

Table 1: Comparing the frequency distribution of baseline information of the study groups

Sociodemographic data	Group 1 *n* (%)	Group 2 *n* (%)	Group 3 *n* (%)	Statistical test	*p*
Age				0.46*	0.79
18-38	5 (25.00)	5 (25.00)	6 (30.00)		
>38-58	10 (50.00)	11 (55.00)	9 (45.00)		
>58-65	5 (25.00)	4 (20.00)	5 (25.00)		
Gender				0.44**	0.80
Male	14 (70.00)	13 (65.00)	12 (60.00)		
Female	6 (30.00)	7 (35.00)	8 (40.00)		
Diagnosis				1.63**	0.95
Internal	14 (70.00)	13 (65.00)	13 (65.00)		
Surgical	1 (5.00)	3 (15.00)	2 (10.00)		
Neurology	2 (10.00)	2 (10.00)	3 (15.00)		
Neurosurgery	3 (15.00)	2 (10.00)	2 (10.00)		
Intubation place				2.72**	0.60
Emergency Ward	13 (65.00)	13 (65.00)	15 (75.00)		
Operation Room	6 (30.00)	7 (35.00)	5 (25.00)		
ICU***	1 (5.00)	0 (0.00)	0 (0.00)		
Intubation method				2.13**	0.34
Emergency	17 (85.00)	13 (65.00)	15 (75.00)		
Selective	3 (15.00)	7 (5.00)	5 (25.00)		
Intubation reason				2.13**	0.34
Respiratory Failure	17 (85.00)	13 (65.00)	15 (75.00)		
Surgery	3 (15.00)	7 (5.00)	5 (25.00)		
Nutrition Status				1.32**	0.52
NPO****	14 (70.00)	14 (70.00)	11 (55.00)		
Enteral Feeding	6 (30.00)	6 (30.00)	9 (45.00)		
Drugs					
Antibiotics	17 (85.00)	19 (95.00)	18 (90.00)	1.16**	0.56
Anticholinergic	10 (50.00)	8 (40.00)	9 (45.00)	0.40**	0.82
Diuretic	10 (50.00)	10 (50.00)	11 (55.00)	0.13**	0.93
Narcotic	17 (85.00)	16 (80.00)	18 (75.00)	0.23**	0.89

*Kruskal-Wallis, **Chi-square, ***Intensive Care Unit, ****Nothing by Mouth

Most of the subjects were male (65.00%), with internal diagnosis (66.66%). The three groups were similar in terms of age, gender, marital status, level of education, diagnosis, location, method and cause of intubation, type of nutrition, and type of medication [Table 1].

They also did not differ significantly in terms of the history of previous diseases (χ^2=15.31, df=16, p=0.50), SOFA score (χ^2=0.52, df=2, p=0.77), and APACHEII score (χ^2=1.78, df=2, p=0.41). Before the intervention, there was no pneumonia in any of the three groups according to the adjusted criterion. The results of the Chi-square test showed that the incidence of VAP on the fourth day of the intervention in the first group (35.00%) was significantly higher than the two intervention groups (10.00%) (χ^2=5.86, df=2, p=0.03). However, there was no significant difference between the three groups on the seventh day of the intervention (χ^2=0.51, df=2, p=0.78). Based on the Cochran's test, the incidence of VAP was not significantly different between the two intervention groups in the three times (Q=2.67, df=2, p=0.26; (Q=3, df=2, p=0.22); but in the first group, it significantly differed in the three times (Q=12.29, df=2, p=0.002) [Table 2].

As the results of the Wilcoxon test showed, the incidence of VAP in the first group was significantly higher in the fourth day of the intervention than before (p = 0.008) and the seventh day of the intervention (p = 0.01); however, there was no significant difference between before the intervention and the seventh day of the intervention (p = 0.32). The result of one-way ANOVA showed that the mean of MCPIS was significantly different between the three groups in the fourth day of the intervention ($F_{2,57}$=3.67, p=0.04), that is, the higher the mean score, the more was the risk of pneumonia. However, the three groups did not differ significantly before the intervention ($F_{2,57}$=0.59, p = 0.56) and the seventh day of the intervention ($F_{2,57}$ = 1.77, p = 0.18). Overall, the toothbrush groups had a 25.00% greater reduction in early VAP than the swab group. As the results of LSD Post-Hoc test showed, in the fourth day of the intervention, the mean of MCPIS was significantly higher in the first group than the second (p = 0.02) and third (p = 0.04) groups; however, there was no significant difference between the second and third groups (p = 0.74). The repeated measures ANOVA showed that the mean of MCPIS in the second group was not significantly different in the three times ($F_{2,18}$=0.41, p=0.67); however, it was significantly different in the third group ($F_{2,18}$=5.53, p=0.013) and the first group ($F_{2,18}$=5.70, p=0.012) in the three-time intervals [Table 3].

According to the LSD Post-Hoc test, the mean of MCPIS in the third group was significantly lower in the seventh day of the intervention than before the intervention (p = 0.04) and the fourth day of the intervention (p = 0.003); however, there was no significant difference between before the intervention and the fourth day of the intervention (p = 0.88). In the first group, the mean of MCPIS was significantly higher in the fourth day of the intervention than the seventh day of the intervention (p = 0.003). However, the pre-intervention period was not significantly different from the fourth day (p = 0.14) and the seventh day (p = 0.67) of the intervention.

Table 2: Comparing the incidence rate of pneumonia based on modified clinical pulmonary infection score at different times in and between the three groups

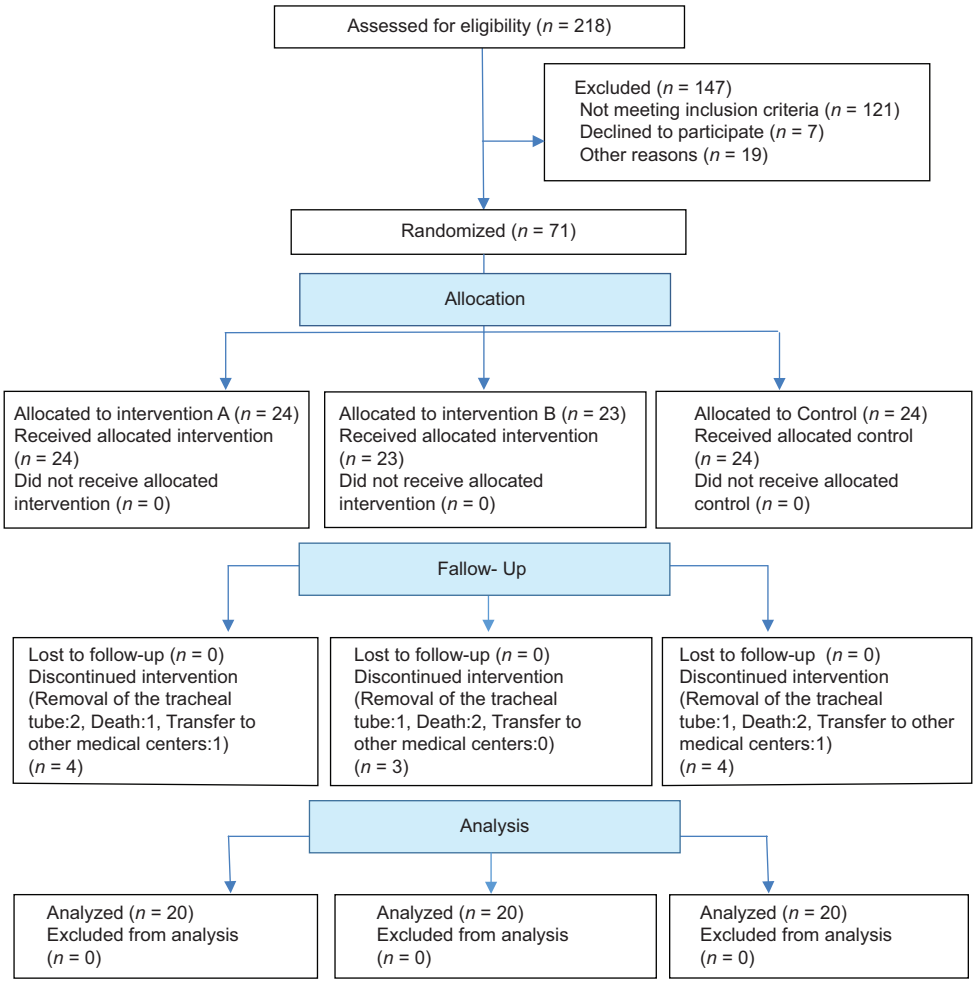
Variable	Modified Clinical Pulmonary Infection Score* (Groups)			Chi-square	*p*
	Intervention 1 *n* (%)	Intervention 2 *n* (%)	Intervention 3 *n* (%)		
Before Intervention	0 (0.00)	0 (0.00)	0 (0.00)	-	1
DAY 4	7 (35.00)	2 (10.00)	2 (10.00)	5.86	0.03
DAY 7	1 (5.00)	2 (10.00)	1 (5.00)	0.51	0.78
Q**	12.29**	2.26**	3.00**		
p	0.002	0.26	0.22		

*Score ≥5=pneumonia (Min Score: 0 and Max Score: 10), **Cochran Test

Table 3: Mean (SD) of MCPIS* in and between three groups before the intervention and the fourth and seventh days after the intervention

Variable	Modified Clinical Pulmonary Infection Score* Groups Mean (SD)			*F****	*p*
	Intervention 1	Intervention 2	Intervention 3		
Before Intervention	3.25 (1.16)	2.80 (1.32)	3 (1.45)	0.59***	0.56
DAY 4	3.85 (1.42)	2.90 (1.25)	3.05 (1.50)	3.67***	0.04
DAY 7	3.10 (1.17)	2.70 (1.30)	2.35 (1.31)	1.77***	0.18
*F***	5.70**	0.41**	5.53**		
p	0.012	0.67	0.013		

*Modified Clinical Pneumonia Infection Score and Score ≥5=pneumonia (Min Score: 0 and Max Score: 10), **The Repeated Measurements ANOVA, ***ANOVA Test



Picture 1: Consort flow diagram

Discussion

This study was conducted to evaluate and compare the effect of three oral care protocols on the incidence of VAP. There was no difference between the three groups in terms of using chemical method oral care (0.20% chlorhexidine mouthwash solution), using oral moisturizing gel, and lip lubrication as well as the time of using them.

The two mechanical methods of swabbing and brushing as well as the number of brushings (two and four times) were compared between the groups. According to the results, the frequency of VAP and the mean of MCPIS in the first group (Swab) were higher than the other two groups in the fourth day of the intervention, indicating a higher rate of incidence and risk of pneumonia in this group. Moreover, in the first group, the incidence of pneumonia was higher in the fourth day of the intervention than before the intervention and the seventh day. The incidence of VAP was not significantly different between the two groups that used toothbrushes (the first and second groups). The reduction in the mean and frequency of infection in the first group, after seven days, may be the result of treatments started after the diagnosis of the infection. The treatments might have produced these results by affecting MCPIS subscales.

Contrary to the present study, Falahinia *et al*.[14] showed that 61.8% of patients using 0.2% chlorhexidine oral care with swabs and 59.9% of patients using 0.2% chlorhexidine with toothbrushes were infected with VAP. They showed that brushing with chlorhexidine was not able to reduce early VAP compared to swabbing with chlorhexidine. In this study, apart from mouthwash and the use of toothbrushes and swabs which were performed twice a day for five days and each time for three minutes, they did not take any other action such as oral moisturizing and the lubrication of lips to maintain the integrity of the oral mucosa and lips. Analyzing the effect of oral care with and without toothbrush, Lorente *et al*.[13] also showed that the use of chlorhexidine-impregnated gauze and the use of soft toothbrush with chlorhexidine were not significantly different in reducing the incidence of VAP in MV patients. In this study, oral care was performed every 8 hours and, in addition to the above measures, 10 cc of chlorhexidine 0.12% was poured into the mouth of the patients of both groups and after 30 seconds the oropharyngeal area was

suctioned. Based on most accepted guidelines, the use of chlorhexidine for preventing the physical and chemical nature of the oral mucosa is recommended every 12 hours. Additionally, another method used in oral care protocols is the method of moisturizing the mouth and lips every 2 to 4 hours, which has had a positive effect on maintaining the moisture and integrity of the tissues of the lips and gums, and prevented the dryness and cracking of the oral areas, which might provide the conditions for the growth of bacteria.[6,23] Given the importance of maintaining the moisture of the oral mucosa and lips in reducing the rate of pneumonia, this issue was tried to be considered in our study. Like the present study, de Lacerda Vidal *et al*.[2] acknowledged the higher incidence of VAP in the oral care recipient group who used chlorhexidine-impregnated swabs compared with the group who used chlorohexidine gel-impregnated toothbrush (28 vs. 18). Although the results were not statistically significant, there was a significant reduction in the duration of mechanical ventilation, the prevalence of VAP, and the length of hospitalization in the ICU among patients who used toothbrush.

According to other results of the study, the mean of MCPIS was significantly different in both the first and the third groups, while it was not significantly different in the second group. In the third group, which used brushing four times a day, the risk of VAP, based on lower mean of MCPIS, was lower on the seventh day of the intervention than before and the fourth day of the intervention. Given that this comparison was not significant in the second group (which used brushing two times) during the three times, it can be said that four times brushing can, to some extent, reduce the risk of VAP more than doing it twice. Unlike the mentioned results, the systematic review study of de Camargo *et al*.[24] showed that adding toothbrushes to the patient care program did not have a significant effect on the prevention and increase of VAP. de Camargo *et al*. analyzed the articles in which toothbrush was part of their oral care program and had no focus on the similarity or difference of other interventions. They also compared only mechanical interventions with each other and did not mention the number of brushing times.[24] In line with the present study, the study of Ory *et al*.[18] pointed to the more incidence of VAP in oral care through using swabs and chlorhexidine compared to toothbrushes and chlorhexidine. However, this study also did not examine the number of brushing times separately, and the significant difference between the two groups showed the continuous effect of using toothbrushes and suction applicators.

In the present study, the incidence of VAP in toothbrush groups was lower than the swab group, and also four times brushing could reduce the risk of VAP better than two times brushing. However, given different care settings and the effect of several reasons on the incidence of VAP, it may not be possible to definitively suggest a superior oral care protocol for the prevention of VAP. Therefore, there is a need for more studies in this area. Despite the fact that during the study, the cuff pressure of the endotracheal tube of patients was periodically managed according to standard protocols, it was not possible to completely control microaspiration and its effects on the incidence of pneumonia. Also, although the medications received by patients were recorded, the type and dose of multiple medications used for patients may still have effects on outcomes that were beyond the control of the researcher.

Conclusion

According to the findings of the study, using toothbrush in the oral care program can reduce the incidence of VAP. Additionally, given the mean of MCPIS, four times daily brushing can be effective in reducing the risk of VAP more than two times brushing. Therefore, the use of mechanical brushing in the oral care program of MV patients together with four-times-brushing instead of two times brushing every 24 hours can be considered the preferred method for reducing the incidence of pneumonia.

Acknowledgments

Our sincere appreciation goes to the Research Deputy of Isfahan University of Medical Sciences, president of the School of Nursing and Midwifery and its Research Deputy, and the presidents of the cooperative hospitals. We also would like to express our warm gratitude to the patients for their participation and the nurses for their collaboration in the study. The approved project number was 398236.

Financial support and sponsorship

Isfahan University of Medical Sciences

Conflicts of interest

Nothing to declare.

References

1. Li Y-T, Wang Y-C, Lee H-L, Tsao S-C, Lu M-C, Yang S-F. Monocyte chemoattractant protein-1, a possible biomarker of multiorgan failure and mortality in ventilator-associated pneumonia. Int J Mol Sci 2019;20:2218.
2. de Lacerda Vidal CF, de Lacerda Vidal AK, de Moura Monteiro JG, Cavalcanti A, da Costa Henriques AP, Oliveira M, *et al*. Impact of oral hygiene involving toothbrushing versus chlorhexidine in the prevention of ventilator-associated pneumonia: A randomized study. BMC Infect Dis 2017;17:1-9.
3. Prendergast V, Kleiman C, King M. The Bedside Oral Exam and the Barrow Oral Care Protocol: Translating evidence-based oral care into practice. Intensive Crit Care Nurs 2013;29:282-90.
4. Kalanuria AA, Mirski M, Ziai W. Ventilator-associated pneumonia in the ICU. Annu Update Intensive Care Emerg Med 2014;2014:65-77.
5. Adam S, Osborne S, Welch J. Critical Care Nursing: Science and Practice. 3th edn. United Kingdom: Oxford University Press; 2017.
6. Urden LD, Stacy KM, Lough ME. Priorities in Critical Care

Nursing-E-Book , 8th edn. Canada: Elsevier Health Sciences; 2019.

7. Darvishi Khezri H, Tahmassebi H. Evaluation the effect of chlorhexidine mouthwash on the ventilator associated pneumonia: Pathogens, incidence and mortality. Aral Med Univ J 2014;17:41-9.
8. Hellyer TP, Ewan V, Wilson P, Simpson AJ. The Intensive Care Society recommended bundle of interventions for the prevention of ventilator-associated pneumonia. J Intensive Care Soc 2016;17:238-43.
9. AACN. Oral care for acutely and critically ill patients. Crit Care Nurse 2017;37:e19-21.
10. Haghighi A, Shafipour V, Bagheri-Nesami M, Baradari AG, Charati JY. The impact of oral care on oral health status and prevention of ventilator-associated pneumonia in critically ill patients. Aust Crit Care 2017;30:69-73.
11. Ghom AG, Ghom SA. Textbook of Oral Medicine, 3th edn. New Dehli:. JP Medical Ltd; 2014.
12. Ames NJ, Sulima P, Yates JM, McCullagh L, Gollins SL, Soeken K, *et al*. Effects of systematic oral care in critically ill patients: A multicenter study. Am J Crit Care 2011;20:e103-14.
13. Lorente L, Lecuona M, Jiménez A, Palmero S, Pastor E, Lafuente N, *et al*. Ventilator-associated pneumonia with or without toothbrushing: A randomized controlled trial. Eur J Clin Microbiol Infect Dis 2012;31:2621-9.
14. Falahinia G, Razeh M, Khatiban M, Rashidi M, Soltanian A. Comparing the effects of chlorhexidine solution with or without toothbrushing on the development of ventilatorassociated pneumonia among patients in ICUs: A singleblind, randomized controlled clinical trial. Hayat 2016;21:41-52.
15. El-Rabbany M, Zaghlol N, Bhandari M, Azarpazhooh A. Prophylactic oral health procedures to prevent hospital-acquired and ventilator-associated pneumonia: A systematic review. Int J Nurs Stud 2015;52:452-64.
16. Zand F, Zahed L, Mansouri P, Dehghanrad F, Bahrani M, Ghorbani M. The effects of oral rinse with 0.2% and 2% chlorhexidine on oropharyngeal colonization and ventilator associated pneumonia in adults' intensive care units. J Crit Care 2017;40:318-22.
17. Nobahar M, Razavi MR, Malek F, Ghorbani R. Effects of hydrogen peroxide mouthwash on preventing ventilator-associated pneumonia in patients admitted to the intensive care unit. Braz J Infect Dis 2016;20:444-50.
18. Ory J, Raybaud E, Chabanne R, Cosserant B, Faure JS, Guérin R, *et al*. Comparative study of 2 oral care protocols in intensive care units. Am J Infect Control 2017;45:245-50.
19. Atashi V, Yazdannik A, Mahjobipoor H, Ghafari S, Bekhradi R, Yousefi H. The effects of Aloe vera-Peppermint (Veramin) moisturizing gel on mouth dryness and oral health among patients hospitalized in intensive care units: A triple-blind randomized placebo-controlled trial. J Res Pharm Pract 2018;7:104-10.
20. Wainwright J, Sheiham A. An analysis of methods of toothbrushing recommended by dental associations, toothpaste and toothbrush companies and in dental texts. Br Dent J 2014;217:E5.
21. Shahabi M, Yousefi H, Yazdannik AR, Alikiaii B. The effect of daily sedation interruption protocol on early incidence of ventilator-associated pneumonia among patients hospitalized in critical care units receiving mechanical ventilation. Iran J Nurs Midwifery Res 2016;21:541-6.
22. Safarabadi M, Ghaznavi-Rad E, Pakniyat A, Rezaie K, Jadidi A. Comparing the effect of echinacea and chlorhexidine mouthwash on the microbial flora of intubated patients admitted to the intensive care unit. Iran J Nurs Midwifery Res 2017;22:481-5.
23. Goldsworthy S. Mechanical ventilation education and transition of critical care nurses into practice. Crit Care Nurs Clin North Am 2016;28:399-412.
24. de Camargo L, da Silva SN, Chambrone L. Efficacy of toothbrushing procedures performed in intensive care units in reducing the risk of ventilator-associated pneumonia: A systematic review. J Periodontal Res 2019;54:601-11.