

# Oral Care in ICU Mechanical Ventilation Patients and Associated Pneumonia: A Literature Review

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## Abstract

**Background:** Poor oral health can lead to hospital-acquired pneumonia, a serious condition that can prolong patient care and increase the risk of mortality. The bacteria found in the oral cavity of patients with periodontal disease can be particularly harmful if inhaled into the lungs. Patients who are on mechanical ventilation are at an increased risk of developing aspiration pneumonia. **Objective:** to investigate the effect of oral care on ventilation associated pneumonia (VAP) and various types of such care. **Methods:** This review article is performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The literature exploration was done in PubMed, Embase, and Web of Science databases for articles published between 2011 and 2023. The search words were "Mechanical ventilation, intubation, pneumonia, dental care, oral care and ICU ". **Results:** A total of 21 studies were included, the studies were randomized controlled trials (RCTs) or quasi-RCTs and observational studies. Twice-daily oral care with tooth brushing using purified water can significantly reduce the incidence of VAP. Oral care with chlorhexidine and brushing, as well as enhanced oral care, can also be effective in reducing the incidence of VAP. Improved education and implementation of oral care protocols with 0.12% chlorhexidine solution can significantly reduce the incidence of VAP. **Conclusions:** The review concludes that good oral hygiene, especially twice-daily oral care with tooth brushing using purified water, can significantly reduce the incidence of VAP in mechanically ventilated patients.

**Keywords:** Mechanical Ventilation, Intubation, Pneumonia, Dental Care, Oral Care, ICU.

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## INTRODUCTION

Intensive care units (ICUs) have patients who often necessitate mechanical ventilation as their inability to breathe unassisted because of accidents, trauma, recent surgery or any other impairing medical conditions. These seriously diseased patients are also in need of hospital personals to deliver their requirements for care and nutrition, including oral care [1].

Generally, the literature proposes that oral care worsens after ICU admission [2, 3]. Marked deterioration in such diseased patients with endotracheal

intubation decrease immunity of oral cavity, may be accompanying oral cavity or respiratory injury, rise the probability of mouth dryness, and making access for oral hygiene more problematic [4, 5]. Accumulation of plaques on teeth is rapid in such patients and with increasing the amount of accumulated plaques, it is more likely to be colonized by pathogens. Absence of oral care leads to exacerbation of plaque colonization, also oral dryness because of continuous opening of mouth with reduced saliva effect represents another factor in exaggerated colonization [5, 6]. Such plaque biofilm complex is considered chemical treatment resistant with

the need of mechanical treatment (e.g. toothbrushing) to remove [7].

Ventilator-associated pneumonia (VAP) is a lung infection that can occur in patients who are receiving mechanical ventilation for at least prior 2 days [8]. It is thought to be caused by bacteria that enter the lungs through the endotracheal tube, which is used to deliver oxygen to the patient. Micro-aspiration of pharyngeal secretions, which can occur around an imperfect seal of the endotracheal tube, is also a contributing factor. Patients who are on a ventilator may accidentally inhale saliva or mucus from their throat, which can lead to infection [9, 10].

The VAP is considered a relatively common nosocomial infection occurring in hospitals. The incidence of VAP has been reported to be between 23.8% and 36.0% in previous studies [11, 12]. The mortality rate associated with VAP is estimated to be 13% [13]. Patients who have VAP also tend to have a longer stay in the intensive care unit (ICU), this long stay could not be known if it is a causative event in the incidence of VAP cases or an effect associated with the disease [14].

There are a number of interventions that can be used to prevent VAP, including the use of antibiotics, either topical intraorally or systemically [15, 16]. However, the overuse of antibiotics can lead to the development of drug-resistant bacteria. Therefore, other approaches to preventing VAP, such as improving the hygiene of the ICU environment and oral hygiene care, are also being investigated. Clinical guidelines recommend that oral hygiene care be provided to patients

who are at risk of developing VAP, but the evidence to support this practice is not clear [17].

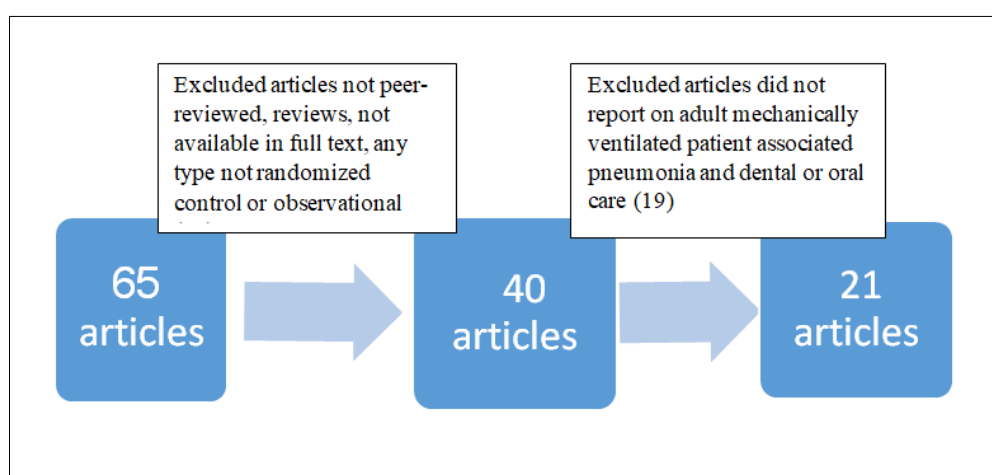
## METHODS

This review article was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The literature exploration was done in PubMed, Embase, and Web of Science databases for articles published between 2011 and 2023. The search words were "Mechanical ventilation, intubation, respiratory infection, lung infection, pneumonia, dental care, oral care, oral hygiene, intensive care, critical care, ICU, adult".

The inclusion criteria were studies that were published in English and conducted in adults critically diseased patients with mechanical ventilation in ICU, having pneumonia after 48 hours or more and evaluated the oral or dental care.

The exclusion criteria were studies that were not peer-reviewed, did not report the results of pneumonia in mechanical ventilation patients or did not report dental or oral care in such patients. Also, Articles that were not available in full text or were reviews or commentaries or letter to editor or editorial or any other research type other than controlled trials and observational studies were not included [Figure 1].

A total of 21 studies were included in this review according to inclusion and exclusion criteria after reviewing the title, abstract and full text of articles. The studies were randomized controlled trials (RCTs) or quasi-RCTs and observational type on adults.



**Figure 1: Summary of article selection**

## RESULTS

In this study 7900 patients were investigated in the included studies. All patients were of ICU and on mechanical ventilation / endotracheal tube. The studied dental care included sodium bicarbonate mouth wash, chlorhexidine 0.2% aqueous oral rinse/gel, toothbrushing using purified water with elevating the

head of the bed, and before-and-after hypopharyngeal suctioning, 0.12% chlorhexidine digluconate, chlorhexidine swabbing, Listerine®, sodium bicarbonate, 0.12% chlorhexidine solution/gel, teeth brushing, with 1% oral chlorhexidine, and oropharyngeal suction, toothbrushing with chlorhexidine, brushing with flossing, and chlorhexidine mouthwash, toothbrushing

with a small-headed toothbrush and a foam-headed swab, 0.2% chlorhexidine, chamomile, and saline.

The effectiveness of oral care and their different types, incidence of VAP, and colonies of microbacteria

on dental plaques and lower respiratory system. Oral care was found to be important in lowering the incidence of VAP and colonization of dental plaque.

**Table 1: Summary of the included studies**

Authors	Oral care	Participant	Results
Berry <i>et al.</i> , 2011 [18]	This study was a feasibility study to test two oral hygiene strategies in mechanically ventilated patients. Group A: second hourly oral rinse with sterile water. Group B: sodium bicarbonate mouth wash second hourly. Group C: twice daily irrigations with chlorhexidine 0.2% aqueous oral rinse and second hourly irrigations with sterile water. All study options included cleaning with a toothbrush and non-foaming toothpaste.	The study included 109 patients. Group A had 43 patients, Group B had 33 patients, and Group C had 33 patients.	Sodium bicarbonate mouth wash showed a greater trend to reduction in bacterial colonization. The incidence of VAP showed no significant difference. The conclusion of the study was that a standardized oral hygiene protocol which includes the use of mechanical cleaning with a toothbrush may be a factor in the reduction of colonization of dental plaque with respiratory pathogens.
Yao <i>et al.</i> , 2011 [19]	This study investigated the effects of brushing teeth twice daily with purified water on the incidence of VAP and oral health in post-neurosurgical ICU patients who had (a) ventilator support for at least 48 to 72 hours and (b) no current pneumonia. The study was a randomized controlled pilot trial. Patients were randomly assigned to one of two groups: the experimental group received twice-daily oral care with toothbrushing using purified water, elevating the head of the bed, and before-and-after hypopharyngeal suctioning; the control group received twice-daily mock oral care.	53 patients; experimental 28 & control 25	The results showed that the incidence of VAP was significantly lower in the experimental group (17%) than in the control group (71%) with significantly better scores for oral health and plaque index in experimental group. The study concluded that toothbrushing twice daily with purified water is an effective way to reduce the incidence of VAP and improve oral health in post-neurosurgical ICU patients.
Lorente <i>et al.</i> , 2012 [20]	This randomized clinical study aimed to compare the incidence of VAP in critical care patients with invasive mechanical ventilation for than 24 h were included who received oral care with and without manual brushing. All patients received oral care with 0.12 % chlorhexidine digluconate. Tracheal aspirate samples were obtained during endotracheal intubation, then twice a week, and, finally, on extubation.	217 patients with toothbrushing vs 219 without toothbrushing	The study found that there was no significant difference in the incidence of VAP between the two groups. This suggests that manual toothbrushing does not help to prevent VAP in critical care patients on mechanical ventilation.
Özçaka <i>et al.</i> , 2012 [21]	This study was a randomized, double-blind, controlled study that looked at the effects of oral care with chlorhexidine swabbing on the development of VAP in mechanically ventilated patients. The patients were randomly assigned to one of two groups: the chlorhexidine group, which received oral care with chlorhexidine swabbing four times a day, and the control group, which received oral care with saline swabbing four times a day.	The study included 61 dentate patients who were scheduled for invasive mechanical ventilation for at least 48 hours.	The authors concluded that the use of oral care with chlorhexidine swabbing to reduce the risk of VAP development in mechanically ventilated patients. They also emphasized the importance of adequate oral hygiene in preventing medical complications.
Berry, 2013 [22]	This prospective, single-blind randomized controlled trial study investigated the effectiveness of two different mouth rinses, Listerine® and sodium bicarbonate, in reducing the colonization of dental plaque with respiratory pathogens and the subsequent development of VAP in adult	398 Patients were randomly assigned to receive either Listerine® mouth rinse twice daily (127), sodium bicarbonate mouth rinse twice daily	The study concluded that Listerine® and sodium bicarbonate mouth rinses were not more effective than sterile water in reducing the colonization of dental plaque or the incidence of VAP in mechanically ventilated patients. The study also found that tooth

	patients who were mechanically ventilated for at least 4 days.	(133), or sterile water twice daily (control group 138). All groups also received tooth brushing three times a day.	brushing is still an important part of oral hygiene in these patients.
Zurmeily, 2013 [23]	The study was conducted in an ICU. Registered nurses attended educational sessions about oral care and also used online education modules. The nurses' care of 180 intubated patients was observed, and changes were noted in practices related to oral care.	180 intubated patients.	After the education intervention, the frequency of oral care increased significantly to tooth brushing every 4 hours and swabbing every 12 hours with 0.12% chlorhexidine solution. The evidence-based practice education intervention decreased VAP rates by 62.5%. The study concluded that significant reductions in VAP rates may be achieved through improved education and implementation of oral care protocols with 0.12% chlorhexidine solution.
Cutler & Sluman, 2014 [24]	Historical control study of all patients who were mechanically ventilated for at least 48 hours in a general adult critical care unit between July 2009 and December 2011. They compared the incidence of VAP in 528 patients who received standard oral care with the incidence in 559 patients who received enhanced oral care, which included teeth brushing, 1% oral chlorhexidine, and oropharyngeal suction.	1087 patients	The incidence and time of VAP was significantly lower in the group that received enhanced oral care compared to the group that received standard oral care. Additionally, the researchers found that the cost of preventing and treating VAP was lower in the group that received enhanced oral care
Nicolosi <i>et al.</i> , 2014 [25]	This quasi-experimental study aimed to determine the effect of toothbrushing and 0.12% chlorhexidine gluconate mouthwash in preventing VAP after cardiac surgery. The first group of patients received toothbrushing and chlorhexidine mouthwash, while the second group received regular oral hygiene care.	Each group comprised 150 patients.	The study concluded that toothbrushing and chlorhexidine mouthwash under the supervision of a dentist can be effective in reducing the incidence of VAP after cardiac surgery.
Lev <i>et al.</i> , 2015 [26]	This prospective, controlled study was conducted to compare the effectiveness of two methods of oral care in preventing VAP in ventilated patients. The Comprehensive oral care: This included tooth brushing, suctioning, sodium bicarbonate, rinsing with an antiseptic solution containing 1.5% hydrogen peroxide, and a mouth moisturizer. The conventional oral care included cleaning with a sponge and atraumatic clamp, and rinsing with a 0.2% solution of chlorhexidine gluconate.	90 patients	The study found that patients who received comprehensive oral care were significantly less likely to develop VAP than patients who received conventional oral care. They concluded that a comprehensive oral hygiene treatment regimen that includes tooth brushing, suctioning and rinsing with an antiseptic is more effective in preventing VAP than more conventional protocols.
Azimi <i>et al.</i> , 2016 [27]	This clinical trial study was conducted to compare the effectiveness of three types of mouthwash in preventing bacterial colonization in the mouths of ICU patients with endotracheal tubes. The three mouthwashes were 0.2% chlorhexidine, chamomile, and saline every 8-48 hours.	39 patients	The study found that 0.2% chlorhexidine mouthwash was more effective than chamomile and saline mouthwashes in preventing bacterial colonization. However, none of the mouthwashes were able to remove pathogens, such as <i>Staphylococcus aureus</i> , <i>Pseudomonas</i> , <i>Klebsiella</i> , and <i>Acinetobacter</i> .
Marino <i>et al.</i> , 2016 [28]	The randomized, assessor-blinded, split-mouth trial aimed to compare the effectiveness of toothbrushing with a small-	The study included 21 adult patients who were orally intubated and	The results showed that both toothbrushing and foam swabs were effective at reducing plaque and gingival inflammation. There was no

	headed toothbrush and a foam-headed swab in mechanically ventilated patients. The study was performed at a single critical care unit. The patients were assigned to have their teeth cleaned on one side of their mouth with a toothbrush and the other side of their mouth with a foam swab. The cleaning was done every 12 hours. The researchers measured the effectiveness of the cleaning by looking at the plaque scores, gingival index, and microbial plaque counts.	expected to be on mechanical ventilation for more than 24 hours and had more than 20 teeth.	significant difference between the two methods. The researchers concluded that both toothbrushing and foam swabs are effective methods of oral care for mechanically ventilated patients.
de Lacerda Vidal <i>et al.</i> , 2017 [29]	The study was a prospective, randomized trial that compared the effectiveness of oral hygiene with toothbrushing and chlorhexidine gel (0.12%) to oral hygiene with chlorhexidine solution (0.12%) without toothbrushing in adult patients who were mechanically ventilated in the ICU.	213 patients were included in the study as 108 were randomized to control group and 105 to intervention group of toothbrushing plus 0.12% chlorhexidine gel	The study found that toothbrushing plus chlorhexidine gel was associated with a lower incidence of VAP than oral hygiene with chlorhexidine solution alone. However, the difference was not statistically significant. Toothbrushing plus chlorhexidine gel was also associated with a significant reduction in the meantime of mechanical ventilation. The study concluded that toothbrushing plus chlorhexidine gel may be beneficial in reducing the incidence of VAP and the duration of mechanical ventilation.
Kaya <i>et al.</i> , 2017 [30]	A study was conducted to compare the effects of two oral care agents, 5% glutamine and 2% chlorhexidine gluconate solution, for the prevention of VAP in neurosurgical ICU patients.	88 patients who were randomly assigned to one of two groups: the study group received oral care with 5% glutamine, and the control group received oral care with 2% chlorhexidine gluconate solution.	The results showed that there was no significant difference in the incidence of VAP between the two groups. There was also no significant difference in the oral health scores between the two groups. However, the APACHE II score was significantly lower at discharge than at day 1 in both groups. They concluded that both 5% glutamine and 2% chlorhexidine gluconate solution are equally effective in preventing VAP in neurosurgical ICU patients
Marino <i>et al.</i> , 2017 [31]	This study investigated the microbiome of dental plaque, endotracheal tubes (ETTs), and non-directed bronchial lavages (NBLs) in mechanically ventilated patients.	Bacterial 16S rRNA gene sequences from 34 samples of dental plaque, non-directed bronchial lavages, and ETTs from 12 adult mechanically ventilated patients.	The researchers found that the microbial communities of these samples were very similar, suggesting that the oral cavity is an important source of bacteria that can be aspirated into the lungs and ETTs. This finding highlights the importance of good oral hygiene in preventing VAP in mechanically ventilated patients.
Atashi <i>et al.</i> , 2018 [32]	This study was a clinical trial that investigated the effect of oral care on the frequency of VAP in patients in ICU. The control group received routine oral care, while the intervention group received oral care that included brushing, flossing, and chlorhexidine mouthwash. Data were collected at the first, third, and fifth days of the study.	80 participants who were randomly assigned to a control group and an intervention group	The authors concluded that the oral care program did not significantly decrease the incidence of VAP in critically ill patients compared with routine oral care practices.
Galhardo <i>et al.</i> , 2020 [33]	This study investigated the impact of oral care and the use of chlorhexidine gluconate in preventing VAP in patients admitted to an ICU.	229 patients	The study concluded that the oral care protocol had a statistically significant effect in reducing the risk of developing early VAP in ICU patients. This demonstrates the importance of



			multidisciplinary teamwork in the hospital setting.
Abd-alraheem <i>et al.</i> , 2020 [34]	The study aimed to assess the effect of oral hygiene for patients on a mechanical ventilator in ICU and the nurses' knowledge and practice.	The study included 40 nurses and 60 patients who were orally intubated and on mechanical ventilation.	The researchers concluded that the nurses' knowledge and practice were unsatisfactory. They also found that there was a highly statistically significant relationship between low frequency of oral care and oral alteration and a highly statistically significant relationship between VAP occurrence and poor oral alteration.
Kes <i>et al.</i> , 2021 [35]	The study was a prospective, single-blinded, randomized controlled trial. The oral health of both 0.12% CHX or placebo groups was assessed before oral care, and on days 2 and 3. Oropharyngeal secretions, ETT aspirates, and non-bronchoscopic bronchoalveolar lavage samples were collected on days 0 and 3.	57 mechanically ventilated adults were randomly assigned to receive either 0.12% CHX or placebo for oral care.	The rate of VAP development was significantly lower in the 0.12% CHX group than in the placebo group. The frequency of oropharyngeal colonization was also significantly lower in the 0.12% CHX group than in the placebo group on day 3. The study concluded that the use of 0.12% CHX for oral care could be effective for preventing VAP and reducing microbial colonization in mechanically ventilated patients.
de Cássia Sabino <i>et al.</i> , 2022 [36]	This retrospective study evaluated a multidisciplinary oral health protocol that was implemented in an adult ICU to prevent VAP. The study compared patients who received the protocol (intervention group) to patients who did not receive the protocol (baseline group).	4,103 patients admitted to the adult ICU	The study concluded that the multidisciplinary oral health protocol was effective in reducing the incidence and mortality of VAP. The study also found that the intervention group had better oral health overall, as measured by the Beck Oral Assessment Scale (BOAS) and the Mucosal Plaque Score (MPS). It suggests that oral health is an important factor in preventing VAP, and that a multidisciplinary approach to oral care can be effective in reducing the incidence and mortality of this serious complication.
Singh <i>et al.</i> , 2022 [37]	a prospective randomized controlled trial that compared the incidence of VAP in two groups of ICU patients: one group received oral care with chlorhexidine wash and teeth brushing (group S), and the other group received oral care with chlorhexidine wash only (group C).	220 ICU patients between 18 and 65 years of age, and of either sex formed of two groups (110 each)	The study concluded that oral care with chlorhexidine wash and teeth brushing is more effective than oral care with chlorhexidine wash only in preventing VAP and lowering mortality rate in ICU patients.
Dobakhti <i>et al.</i> , 2023 [38]	This randomized clinical trial study aimed to determine the effect of chlorhexidine mucoadhesive gel on the prevention of VAP in critical patients. The study two groups: one group received 0.2% chlorhexidine mucoadhesive gel and the other group received 0.2% chlorhexidine solution as a mouthwash.	64 ventilated patients	There was no statistically significant difference in the incidence of VAP, number of days connected to the ventilator, the number of days hospitalized in the ICU, or the death rate between the two groups. However, the incidence of VAP was clinically lower in the group that received chlorhexidine mucoadhesive gel (15.6%) than in the group that received chlorhexidine solution (25%).

## DISCUSSION

Ventilator-associated pneumonia (VAP) is a serious infection that can occur in patients who are mechanically ventilated. It is the most common hospital-

acquired infection in the ICU, and it can lead to increased morbidity and mortality. Oral care is an important part of preventing VAP. It helps to remove plaque and bacteria

from the mouth, which can reduce the risk of them being aspirated into the lungs.

There is a growing body of evidence that suggests that oral care can be effective in reducing the incidence of VAP. For example, a study published in *Journal of Nursing Research* found that incidence of VAP was significantly lower in ICU ventilation patients received twice-daily oral care with tooth brushing using purified water, in addition to better scores for oral health and plaque index [19].

Another study, published by Özçaka and his colleagues, found that oral care with chlorhexidine and brushing was effective in reducing the incidence of VAP in critically ill patients [21]. This was comparative with the results obtained in a more recent study in 2021 [35].

Another study proved that enhanced oral care (which included teeth brushing, 1% oral chlorhexidine, and oropharyngeal suction) was effective in reducing the incidence of VAP in patients with mechanical ventilation [24].

Finally, a study published in the journal of *respiratory care* found that toothbrushing and chlorhexidine mouthwash under the supervision of a dentist can be effective in reducing the incidence of VAP in critically ill patients [25].

Overall, the evidence suggests that oral care can be an effective way to reduce the incidence of VAP in ICU ventilation patients. The most effective oral care regimen is likely to include a combination of tooth brushing, chlorhexidine mouthwash, and oropharyngeal suction.

Chlorhexidine is a broad-spectrum antiseptic that is effective against a wide range of bacteria and fungi. It is recommended by the Centers for Disease Control and Prevention (CDC) for use in oral care protocols for mechanically ventilated patients. A number of studies have shown that oral care protocols with chlorhexidine can significantly reduce the risk of VAP. Significant reductions in VAP rates may be achieved through improved education and implementation of oral care protocols with 0.12% chlorhexidine solution [23-34].

There is highly statistically significant relationship between low frequency of oral care and oral alteration and a highly statistically significant relationship between VAP occurrence and poor oral alteration [33]. Multidisciplinary oral health protocol was effective in reducing the incidence and mortality of VAP [35].

Multidisciplinary oral health protocols involve the collaboration of healthcare professionals from different disciplines, such as nurses, respiratory

therapists, and dentists, to provide comprehensive oral care for mechanically ventilated patients. These protocols have also been shown to be effective in reducing the risk of VAP. There is also evidence that small, soft toothbrush as part of an oral hygiene regimen may be beneficial in mechanically ventilated patients, which can help to reduce the risk of VAP [22]. It was shown that a comprehensive oral hygiene treatment regimen that includes tooth brushing, suctioning and rinsing with an antiseptic is more effective in preventing VAP than more conventional protocols [26]. 0.2% chlorhexidine mouthwash was more effective in preventing bacterial colonization in the mouths of ICU patients with endotracheal tubes [27].

Moreover, both toothbrushing and foam swabs are effective methods of oral care for mechanically ventilated patients [28]. Toothbrushing plus chlorhexidine gel in oral care showed reduction in incidence and time of VAP. [29]. Both 5% glutamine and 2% chlorhexidine gluconate solution are equally effective in preventing VAP [30]. Researchers proved that oral cavity is an important source of bacteria that can be aspirated into the lungs and endotracheal tubes which highlights the importance of good oral hygiene in preventing VAP in mechanically ventilated patients [31]. The incidence of VAP was clinically lower in the group that received chlorhexidine mucoadhesive gel [37].

When comparing sodium bicarbonate mouth wash and chlorhexidine 0.2% aqueous oral rinse, one study showed that both can act as oral hygiene with no significant difference in incidence of VAP [18], and another study proved that using oral care with 0.12% chlorhexidine digluconate and manual brushing [20], could be effective in the same way.

Moreover, Listerine® and sodium bicarbonate mouth rinses were not more effective than sterile water, both almost had the same results [22]. No significant difference between toothbrushing and foam swabs, both can be used as an alternate with the same effect [28], also, the oral care program did not significantly decrease the incidence of VAP in critically ill patients compared with routine oral care practices [32], this can be attributed to the decreased number of the studied cases.

## CONCLUSION

In conclusion, the studies suggest that good oral hygiene, especially twice-daily oral care with tooth brushing, can significantly reduce the incidence of VAP in mechanically ventilated patients. This also can be obtained by improved education of nurses and implementation of oral care protocols with 0.12% chlorhexidine solution. Other effective oral care interventions include oral care with chlorhexidine and brushing, enhanced oral care under the supervision of a dentist, and a comprehensive oral hygiene treatment regimen.

## REFERENCES

- Zhang, Q., Li, C., Worthington, H. V., & Hua, F. (2020). Oral hygiene care for critically ill patients to prevent ventilator-associated pneumonia. *Cochrane Database of Systematic Reviews*, (12).
- Sachdev, M., Ready, D., Brealey, D., Ryu, J. H., Bercades, G., Nagle, J., ... & Needleman, I. (2013). Changes in dental plaque following hospitalisation in a critical care unit: an observational study. *Critical Care*, 17, 1-7.
- Terezakis, E., Needleman, I., Kumar, N., Moles, D., & Agudo, E. (2011). The impact of hospitalization on oral health: a systematic review. *Journal of clinical periodontology*, 38(7), 628-636.
- Labeau, S. O., Van de Vyver, K., Brusselaers, N., Vogelaers, D., & Blot, S. I. (2011). Prevention of ventilator-associated pneumonia with oral antiseptics: a systematic review and meta-analysis. *The Lancet infectious diseases*, 11(11), 845-854.
- Alhazzani, W., Smith, O., Muscedere, J., Medd, J., & Cook, D. (2013). Toothbrushing for critically ill mechanically ventilated patients: a systematic review and meta-analysis of randomized trials evaluating ventilator-associated pneumonia. *Critical care medicine*, 41(2), 646-655.
- Sands, K. M., Twigg, J. A., Lewis, M. A., Wise, M. P., Marchesi, J. R., Smith, A., ... & Williams, D. W. (2016). Microbial profiling of dental plaque from mechanically ventilated patients. *Journal of medical microbiology*, 65(2), 147-159.
- Marsh, P. D. (2010). Microbiology of dental plaque biofilms and their role in oral health and caries. *Dental Clinics*, 54(3), 441-454.
- American Thoracic Society, & Infectious Diseases Society of America. (2005). Guidelines for the management of adults with hospital-acquired, ventilator-associated, and healthcare-associated pneumonia. *American journal of respiratory and critical care medicine*, 171(4), 388.
- Azoulay, E., Timsit, J. F., Tafflet, M., de Lassence, A., Darmon, M., Zahar, J. R., ... & Outcomerea Study Group. (2006). Candida colonization of the respiratory tract and subsequent pseudomonas ventilator-associated pneumonia. *Chest*, 129(1), 110-117.
- Mojon, P. (2002). Oral health and respiratory infection. *Journal-Canadian Dental Association*, 68(6), 340-345.
- Ding, C., Zhang, Y., Yang, Z., Wang, J., Jin, A., Wang, W., ... & Zhan, S. (2017). Incidence, temporal trend and factors associated with ventilator-associated pneumonia in mainland China: a systematic review and meta-analysis. *BMC infectious diseases*, 17, 1-10.
- Li, Y., Liu, C., Xiao, W., Song, T., & Wang, S. (2020). Incidence, risk factors, and outcomes of ventilator-associated pneumonia in traumatic brain injury: a meta-analysis. *Neurocritical care*, 32(1), 272-285.
- Melsen, W. G., Rovers, M. M., Groenwold, R. H., Bergmans, D. C., Camus, C., Bauer, T. T., ... & Bonten, M. J. (2013). Attributable mortality of ventilator-associated pneumonia: a meta-analysis of individual patient data from randomised prevention studies. *The Lancet infectious diseases*, 13(8), 665-671.
- Apostolopoulou, E., Bakakos, P., Katostaras, T., & Gregorakos, L. (2003). Incidence and risk factors for ventilator-associated pneumonia in 4 multidisciplinary intensive care units in Athens, Greece. *Respiratory care*, 48(7), 681-688.
- D'Amico, R., Pifferi, S., Torri, V., Brazzi, L., & Parmelli, E. (2009). Antibiotic prophylaxis to reduce respiratory tract infections and mortality in adults receiving intensive care. *Cochrane Database of Systematic Reviews*, (4).
- Arthur, L. E., Kizor, R. S., Selim, A. G., van Driel, M. L., & Seoane, L. (2016). Antibiotics for ventilator-associated pneumonia. *Cochrane Database of Systematic Reviews*, (10).
- Khasanah, I. H., Sae-Sia, W., & Damkliang, J. (2019). The effectiveness of oral care guideline implementation on oral health status in critically ill patients. *SAGE Open Nursing*, 5, 2377960819850975.
- Berry, A. M., Davidson, P. M., Masters, J., Rolls, K., & Ollerton, R. (2011). Effects of three approaches to standardized oral hygiene to reduce bacterial colonization and ventilator associated pneumonia in mechanically ventilated patients: a randomised control trial. *International journal of nursing studies*, 48(6), 681-688.
- Yao, L. Y., Chang, C. K., Maa, S. H., Wang, C., & Chen, C. C. H. (2011). Brushing teeth with purified water to reduce ventilator-associated pneumonia. *Journal of Nursing Research*, 19(4), 289-297.
- Lorente, L., Lecuona, M., Jiménez, A., Palmero, S., Pastor, E., Lafuente, N., ... & Sierra, A. (2012). Ventilator-associated pneumonia with or without toothbrushing: a randomized controlled trial. *European journal of clinical microbiology & infectious diseases*, 31, 2621-2629.
- Özçaka, Ö., Başoğlu, Ö. K., Buduneli, N., Taşbakan, M. S., Bacakoğlu, F. E. Z. A., & Kinane, D. F. (2012). Chlorhexidine decreases the risk of ventilator-associated pneumonia in intensive care unit patients: a randomized clinical trial. *Journal of periodontal research*, 47(5), 584-592.
- Berry, A. M. (2013). A comparison of Listerine® and sodium bicarbonate oral cleansing solutions on dental plaque colonisation and incidence of ventilator associated pneumonia in mechanically ventilated patients: A randomised control trial. *Intensive and Critical Care Nursing*, 29(5), 275-281.
- Zurmehly, J. (2013). Oral care education in the prevention of ventilator-associated pneumonia: quality patient outcomes in the intensive care



- unit. *The Journal of Continuing Education in Nursing*, 44(2), 67-75.
24. Cutler, L. R., & Sluman, P. (2014). Reducing ventilator associated pneumonia in adult patients through high standards of oral care: a historical control study. *Intensive and Critical Care Nursing*, 30(2), 61-68.
  25. Nicolosi, L. N., del Carmen Rubio, M., Martinez, C. D., González, N. N., & Cruz, M. E. (2014). Effect of oral hygiene and 0.12% chlorhexidine gluconate oral rinse in preventing ventilator-associated pneumonia after cardiovascular surgery. *Respiratory care*, 59(4), 504-509.
  26. Lev, A., Aied, A. S., & Arshed, S. (2015). The effect of different oral hygiene treatments on the occurrence of ventilator associated pneumonia (VAP) in ventilated patients. *Journal of infection prevention*, 16(2), 76-81.
  27. Azimi, M., Jouybari, L., Moghadam, S., Ghaemi, E., Behnampoor, N., Sanagoo, A., & Hesam, M. (2016). Antimicrobial effects of chlorhexidine, matrica drop mouthwash (chamomile extract), and normal saline on hospitalized patients with endotracheal tubes. *Iranian journal of nursing and midwifery research*, 21(5), 458-463.
  28. Marino, P. J., Hannigan, A., Haywood, S., Cole, J. M., Palmer, N., Emanuel, C., ... & Williams, D. W. (2016). Comparison of foam swabs and toothbrushes as oral hygiene interventions in mechanically ventilated patients: a randomised split mouth study. *BMJ open respiratory research*, 3(1), e000150.
  29. de Lacerda Vidal, C. F., Vidal, A. K. D. L., Monteiro, J. G. D. M., Cavalcanti, A., Henriques, A. P. D. C., Oliveira, M., ... & Lacerda, H. R. (2017). Impact of oral hygiene involving toothbrushing versus chlorhexidine in the prevention of ventilator-associated pneumonia: a randomized study. *BMC infectious diseases*, 17, 1-9.
  30. Kaya, H., Turan, Y., Tunalı, Y., Aydın, G. Ö., Yüce, N., Gürbüz, Ş., & Tosun, K. (2017). Effects of oral care with glutamine in preventing ventilator-associated pneumonia in neurosurgical intensive care unit patients. *Applied Nursing Research*, 33, 10-14.
  31. Marino, P. J., Wise, M. P., Smith, A., Marchesi, J. R., Riggio, M. P., Lewis, M. A., & Williams, D. W. (2017). Community analysis of dental plaque and endotracheal tube biofilms from mechanically ventilated patients. *Journal of critical care*, 39, 149-155.
  32. Atashi, V., Yousefi, H., Mahjobipoor, H., Bekhradi, R., & Yazdannik, A. (2018). Effect of oral care program on prevention of ventilator-associated pneumonia in intensive care unit patients: a randomized controlled trial. *Iranian journal of nursing and midwifery research*, 23(6), 486-490.
  33. Galhardo, L. F., Ruivo, G. F., Santos, F. O., Ferreira, T. T., Santos, J., Leão, M. V., & Pallos, D. (2020). Impact of oral care and antiseptics on the prevalence of ventilator-associated pneumonia. *Oral Health Prev Dent*, 18(1), 331-336.
  34. Abd-alraheem, A. A., A Mohamed, H., & F Gendy, J. (2020). Effect of Oral Hygiene for Patients on Mechanical Ventilator in Intensive Care Unit. *Egyptian Journal of Health Care*, 11(2), 1105-1116.
  35. Kes, D., Yildirim, T. A., Kuru, C., Pazarlıoğlu, F., Ciftci, T., & Ozdemir, M. (2021). Effect of 0.12% chlorhexidine use for oral care on ventilator-associated respiratory infections: A randomized controlled trial. *Journal of Trauma Nursing/ JTN*, 28(4), 228-234.
  36. de Cássia Sabino, B., Falcão, A. L. E., Coelho, M. S., TerziCoelho, C. B., D'Ottaviano, L., Padovani, R., ... & Mello, M. M. (2022). The impact of dental care intervention on ventilator-associated events: A Quasi-experimental study. *American journal of infection control*, 50(9), 1055-1059.
  37. Singh, P., Arshad, Z., Srivastava, V. K., Singh, G. P., & Gangwar, R. S. (2022). Efficacy of oral care protocols in the prevention of ventilator-associated pneumonia in mechanically ventilated patients. *Cureus*, 14(4).
  38. Dobakhti, F., Zargar, A., & Naghibi, T. (2023). The Impact of Chlorhexidine Mucoadhesive Gel in the Prevention of Ventilator-Associated Pneumonia: A Randomized Clinical Trial. *Bulletin of Emergency & Trauma*, 11(1), 26.