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Original Research Article

Ventilator-Associated Pneumonia and Oral Care: A Literature Review

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Abstract:

Background: Ventilator-associated pneumonia is a nosocomial infection that occurs after 48 hours in patients receiving mechanical ventilation through endotracheal intubation. The risk of developing VAP increases with the duration of mechanical ventilation due to colonization by pathogenic microorganisms in the oral cavity and lower respiratory tract. A standardized oral care protocol significantly improved oral health status and decreased the risk of developing VAP.

Methods: Out of a total of 56 articles between 2016 and 2026, a total of 19 articles were assessed. Out of these, 10 studies were included in the review. The population studied in the present review comprised patients admitted to intensive care receiving mechanical ventilation. The present study was carried out in accordance with the PRISMA guidelines

Results: A significant reduction in VAP incidence was observed in various studies with the use of 0.12%–0.2% chlorhexidine. Mechanical plaque removal also reduced the incidence of VAP. Chlorhexidine proved effective in reducing the total number of bacteria present in the mouth, including Staphylococcus aureus and Klebsiella pneumoniae.

Conclusion: Integrating effective oral hygiene practices and adopting a multidisciplinary approach can significantly improve clinical outcomes for critically ill patients, thereby reducing the morbidity and mortality associated with VAP.

Keywords: Oral, ventilator-associated pneumonia, VAP, ICU.

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Introduction

One important aspect of preventing ventilator-associated pneumonia (VAP) is proper oral hygiene in the intensive care unit (ICU). Oral health care measures, such as chlorhexidine (CHX), toothbrushes and swabs, water and povidone-iodine, are used to provide oral hygiene care in clinical practice. These may be used alone or in combination [1].

In the context of healthcare-associated infections (HCAs), pneumonia is the second most frequent and severe infection among hospitalised patients. It results from an inflammatory response in the pulmonary parenchyma and the uncontrolled penetration of infectious agents, such as multidrug-resistant microorganisms, leading to severe respiratory signs and symptoms. Endotracheal intubation and mechanical ventilation are widely used to ensure adequate oxygenation and can save patients' lives in the intensive care unit (ICU). However, these interventions can be deleterious since ventilator-associated pneumonia (VAP) can

occur after 48 hours of intubation. Ventilator-Associated Pneumonia (VAP) has a high prevalence in the ICU, representing one of the main infectious complications in severe patients, and is related to high mortality rates [2]. In intensive care units, VAP is one of the major causes of high morbidity and mortality. The risk of developing VAP increases with the duration of mechanical ventilation due to colonization by pathogenic microorganisms in the oral cavity and lower respiratory tract [3]. One effective preventive measure is the systematic and structured implementation of an oral care protocol. This protocol includes oral hygiene interventions aimed at maintaining oral cleanliness, reducing colonization by pathogenic microorganisms, and preventing the transmission of infection to the lower respiratory tract. Several studies have demonstrated that using antiseptic solutions, such as chlorhexidine, in oral care can significantly reduce the incidence of VAP [4].

Various studies have observed the critical role of structured oral care protocols in improving oral health outcomes among mechanically ventilated patients. A standardized oral care protocol significantly improved oral health status, as measured by the Beck Oral Assessment Scale (BOAS)in a few studies, particularly in the domains of teeth, saliva, and mucosal integrity. These findings support the notion that systematic oral care is not merely a supportive intervention but a clinically relevant strategy that directly influences patient outcomes in the ICU setting [5].

Methodology

The present study was carried out in accordance with the PRISMA guidelines (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). The PICOS approach was used in order to formulate the guiding question, where "P" refers to the population or patient; "I" to the intervention; "C" to the comparison; "O" to the outcome; and "S" to the study design. The studies were identified using search strategies from the databases (PubMed, EBSCO, and Google Scholar) as described in Table 1, with articles published in English between 2016 and 2026.

The keywords used in the article search were oral and Ventilator-Associated Pneumonia. The search was conducted between June and July 2026. The data used in this study were secondary, obtained not from direct observation but from prior research studies. The article selection process and its results are illustrated in the flow diagram as shown in Figure 1.

After identifying the studies from these databases, two researchers carefully assessed them. Duplicate papers were excluded. Titles and abstracts were then examined. The papers that did not fit the PICOS parameters were excluded.

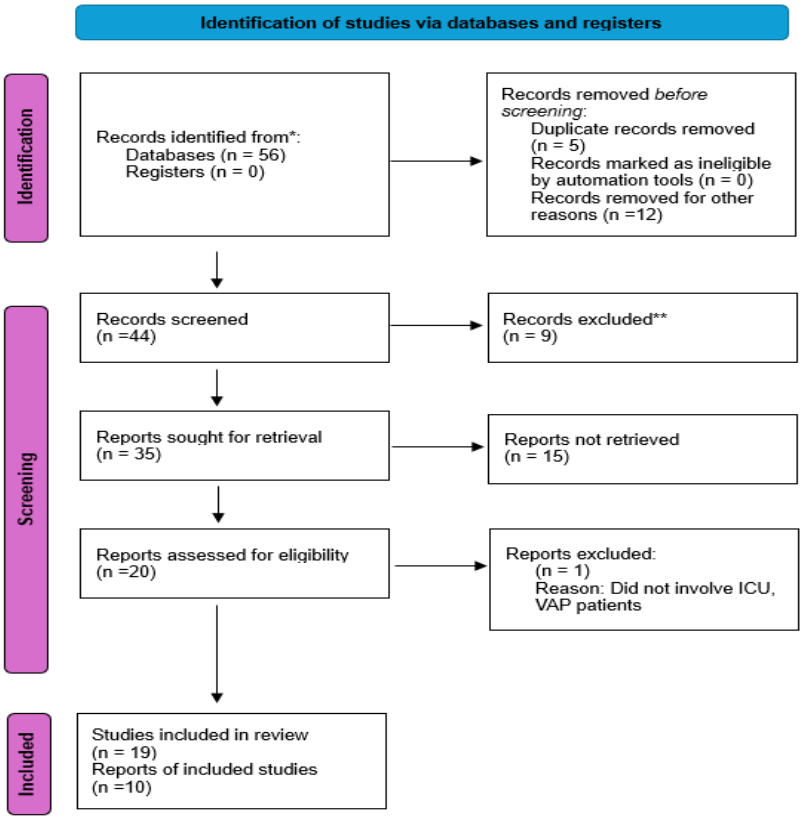

Figure 1: Flowchart of the methodology used to identify research for this study.

Table 1: Main characteristics of the studies

Studies	Study Design	Year of publication	Population	Sex M/F	Age
Haghighi [6]	Randomised clinical trial	2016	Control group (n = 50) Intervention group (n = 50)	Not specified	51.5 ± 1.3 (control) 52.1 ± 1.2 (intervention)
de Lacerda Vidal [7]	Randomized study	2017	Control group (n = 108) Intervention group (n = 105)	54/54 (control) 51/54 (intervention)	63.2 ± 14.5 (control) 59.4 ± 14.5 (intervention)
Zand [8]	Randomised clinical trial	2017	Control group (n = 57) Intervention group (n = 57)	92/22 Control and Intervention group [80.7% male 19.3% female]	45.43 ± 2.95 (control) 44.45 ± 2.72 (intervention)
Tuon [9]	Prospective, randomised, controlled study	2017	Control group (n = 7) Intervention group (n = 16)	4/4 (control) 5/3 (intervention)	48.2 (control) 53.1 (Intervention)
Tsuda [10]	Randomized controlled study	2020	Control group (n = 8) Intervention group (n = 8)	4/3 (control) 10/6 (intervention)	65.8 (control) 63.5 (Intervention)
Galhardo LF [11]	Descriptive retrospective study	2020	2012 group (n = 229) 2013 group (n = 329)	Not specified	Not specified
Kes [12]	Randomized controlled study	2021	Control group (n = 28) Intervention group (n = 29)	16/12 (control) 18/11 (intervention)	77.37 ± 10,1 (control) 72.79 ± 12 (Intervention)
Choi [13]	Randomized Controlled Trial	2022	Control group (n = 28) Intervention group (n = 29)	19/9 (control) 20/9 (intervention)	57.43 ± 16.94(control) 60.62 ± 15.67 (intervention)
Santos [14]	Randomised clinical trial	2024	Control group (n = 45) Intervention group (n = 45)	25/45 (Control) 31/45 (Intervention)	The mean age- Control group = 63 years Intervention group = 65 years
Unahalekhaka A [15]	Quasi-experimental, pre and post-intervention study	2025	14 participating hospitals over (34,731 ventilator-days)	Not specified	Not specified

Results

The literature search generated 56 references; of these, 5 were duplicates, and 12 were removed before screening for not meeting the criteria. 44 articles were screened; 9 review articles without clear results were excluded. 35 articles were sought for retrieval; however,15 articles could not be retrieved. 20 articles were assessed; 1 article was removed because it did not involve ICU, VAP patients. In the end, 10 studies were included in the review (6–15), as shown in Table 1. The population studied in the present review comprised patients admitted to intensive care receiving mechanical ventilation.

The evaluated oral hygiene interventions included plaque removal using toothbrushes, oral swabs, 0.12%–0.2% chlorhexidine, and povidone-iodine. The use of povidone-iodine was less common,

present in only one study [16]. Interventions, outcomes, and complications from the selected articles have been reported in a table (Table 2).

TABLE 2: Interventions, outcomes, and complications reported.

Sl. no	Studies Included	Year	Intervention	Outcome	Complication
1.	Haghighi [6]	2016	The control group included brushing teeth once a day and rinsing with a chlorhexidine solution twice a day. Intervention group included adjusting endotracheal tube pressure; brushing teeth and gums with a children's toothbrush; rinsing with saline solution; spraying chlorhexidine on the teeth, tongue, and gums, followed by deep suctioning; and hydrating the lips and mouth with vitamin A + D.	The intervention group showed a significant improvement in oral health compared to the control group. The incidence of ventilator-associated pneumonia was reduced in the intervention group. The average BOAS score in the intervention group decreased from 10.7 on the first day to 8.9 on the fifth day, whereas it increased from 10.46 on the first day to 11.3 on the fifth day in the control group.	There were 3 deaths in the control group and 2 in the intervention group. The incidence of VAP was lower in the intervention group than in the control group, although it was not statistically significant.
2.	De Lacerda Vidal [7]	2017	In the control group, 0.12% chlorhexidine oral solution was used and in the intervention group, tooth brushing with 0.12% chlorhexidine gel were used	Development of VAP was 28 in Control group and 17 in intervention group.	The deaths were 27 in the control group and 20 in the intervention group.
3.	Zand [8]	2017	0.2% chlorhexidine solution in one group and 2% chlorhexidine solution in the other group.	The incidence of VAP in the 0.2% chlorhexidine group was 22.8% (13 of 57), and the incidence of VAP in the 2% chlorhexidine group was 5.3% (3 of 57)	Totally, 16 deaths occurred in the ICUs, from which 9 (15.8%) and 7 (12.3%) deaths were related to the 0.2% and 2% chlorhexidine groups, respectively.
4.	Tuon [9]	2017	Oral rinse with 15 mL of a 2% chlorhexidine digluconate solution. The solution was brushed onto the gums, oral mucosa, and tongue twice a day. The placebo group received an oral rinse with a 0.9% NaCl solution.	The CHX group, when compared with the placebo group, observed a Lower incidence of methicillin-resistant Staphylococcus aureus (MRSA).	4 patients in the CHX group and 2 patients in the placebo group developed VAP.
5.	Tsuda [10]	2020	3% hydrogen peroxide and irrigation with 200 mL of tap water were used for daily oral care. In the intervention group, 10% povidone-iodine (5 mL) was applied topically.	Povidone-iodine significantly reduced bacterial growth in the intervention group for up to 3 hours after application and did not disturb the balance of the oral microbiota or promote the growth of resistant microorganisms.	The small sample size and the limited follow-up duration (up to 3 hours) were acknowledged limitations that may have restricted the observation of long-term complications.

6.	Galhardo LF [11]	2020	Chlorhexidine gluconate (0.12%) and disposable toothbrushes.	A reduction in the percentage of VAP development was observed. Of the 229 patients admitted to the ICU in 2012, 38 (16.59%) developed VAP. In 2013, 37 of 329 patients (11.25%) developed VAP. There was a tendency towards a lower risk of VAP development following the application of the oral care protocol.	There was a reduction in the number of cases of early-onset pneumonia. In 2012, of the 38 patients, six (15.79%) occurred early, whereas in 2013, of the 37 patients, only three (8.11%) occurred prematurely.
7.	Kes [12]	2021	The intervention group received oral hygiene using a 0.12% chlorhexidine gluconate solution three times a day. Whereas the control group received oral hygiene three times a day using sodium bicarbonate.	The incidence of VAP was significantly lower in the CHX group. There was a lower incidence of oropharyngeal colonization in the CHX group.	In the CHX group, 2 patients developed VAP. In the placebo group, 5 patients developed VAP.
8.	Choi [13]	2022	The intervention group used 0.12% CHX, while the control group received general oral hygiene care.	No cases of VAP were observed in the intervention group. The levels of micro-organisms decreased significantly.	There were two cases of death in the control group. Due to various factors, including deaths, extubations, and transfers, the study had a relatively high dropout rate (about 34%).
9.	Santos [14]	2024	The intervention consisted of using gauze soaked in 0.12% chlorhexidine digluconate, a wooden spatula, and a toothbrush soaked in 0.12% chlorhexidine gel.	Results demonstrate that oral hygiene using a suction toothbrush with 0.12% chlorhexidine gel proved to be more effective than conventional hygiene (using gauze soaked in 0.12% chlorhexidine) at reducing the CFU of potentially pathogenic organisms in patient saliva	This study has limitations, it is small, single-centre, and has not taken into account the incidence of VAP itself.
10.	Unahalekhaka A [15]	2025	Use a sterile syringe with 10e20 mL of sterile water to clean the oral cavity after brushing, and then use a moistened sponge with 0.12% chlorhexidine.	The VAP rates for all 14 hospitals combined were 7.74 per 1000 ventilator-days in 2022 and 5.30 per 1000 ventilator-days in 2023. Which was a significant reduction in their VAP rates.	Significant reduction in the incidence of VAP. The study does not account for other potential factors influencing the reduction in VAP rates, and the use of self-reported data from nurses introduces potential bias.

Mechanical plaque removal showed a significant reduction in the incidence of ventilator-associated pneumonia (VAP). One study found that toothbrush use reduced the incidence of VAP and also the duration of mechanical ventilation [13].

A significant reduction in VAP incidence was observed with the use of 0.12%–0.2% chlorhexidine. Chlorhexidine proved effective in reducing the total number of bacteria present in the mouth, including Staphylococcus aureus and Klebsiella pneumoniae [12].

Discussion

The study observed the critical importance of oral hygiene management in intensive care patients, particularly for preventing ventilator-associated pneumonia (VAP). VAP remains one of the most severe and frequent complications in intensive care units, contributing to high morbidity and mortality rates. Oral hygiene interventions, such as chlorhexidine use and mechanical plaque removal, have shown a significant impact on reducing VAP incidence. This aligns with previous research highlighting chlorhexidine's effectiveness in lowering oral bacterial load and preventing respiratory infections (16). Combining mechanical plaque removal with chlorhexidine use yielded the most favourable outcomes in reducing VAP incidence and improving oral hygiene. While studies (13) demonstrated a significant decrease in VAP incidence due to mechanical plaque removal. The use of Chlorhexidine has been shown to reduce VAP incidence and bacterial colonization of the respiratory tract, making it an important component of oral hygiene protocols for intensive care patients (7,9,12). There were limited studies on the use of povidone-iodine; only one study in the present review reported its use in VAP (10). More studies are therefore required for alternative oral hygiene measures, especially in patients allergic to chlorhexidine. The best result was observed with a combination of mechanical removal and chlorhexidine. Therefore, it is important to combine various oral hygiene techniques to more effectively maintain a healthy oral environment and prevent infections (17).

Despite the methods used to enhance oral conditions in mechanically ventilated intensive care patients, VAP remains a significant complication (18). Some studies reported patient deaths; however, it is crucial to note that these were due to concomitant pathologies and the severity of critical illness rather than being related to oral health or oral hygiene measures (6.7).

Integrating standardised oral hygiene protocols in intensive care units is recommended. The use of chlorhexidine should be combined with mechanical plaque removal to maximize effectiveness (19).

A multidisciplinary ICU framework, with dental professionals being an integral part of the multidisciplinary team, is important to ensure consistent delivery of oral care and to reduce the risk of VAP, as poor oral health, periodontal disease, and increased oral bacterial load may act as modifiable risk factors for VAP, particularly in patients with compromised immune responses. This review has several limitations; the studies included in the review show substantial heterogeneity in study design, sample size, oral hygiene protocols, intervention frequency, and outcome measures, limiting direct comparability. Additionally, follow-up periods were often short, potentially leading to underestimation of long-term outcomes and complications. There is a need for further large-scale, well-designed randomized controlled trials with standardized protocols.

Conclusion

In conclusion, integrating effective oral hygiene practices and adopting a multidisciplinary approach can significantly improve clinical outcomes for critically ill patients, thereby reducing the morbidity and mortality associated with VAP. The implementation of evidence-based oral care protocols to optimise the management of patients in intensive care is essential in reducing the incidence of VAP.

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