

**SAÚDE BUCAL EM PACIENTES INTERNADOS EM UNIDADE DE TERAPIA INTENSIVA: PARTICULARIDADES, ATUAÇÃO ODONTOLÓGICA E PREVENÇÃO DA PNEUMONIA ASSOCIADA À VENTILAÇÃO MECÂNICA**

**ORAL HEALTH IN PATIENTS ADMITTED TO THE INTENSIVE CARE UNIT: PARTICULARITIES, DENTAL PERFORMANCE AND PREVENTION OF VENTILATOR-ASSOCIATED PNEUMONIA**

**SALUD BUCAL EN PACIENTES INTERNADOS EN UNIDAD DE CUIDADOS INTENSIVOS: PARTICULARIDADES, ACTUACIÓN ODONTOLÓGICA Y PREVENCIÓN DE LA NEUMONÍA ASOCIADA A VENTILACIÓN MECÁNICA**

**Derlano Bentes Capucho**

Master in Health Science, Boa Vista Municipal Government – Roraima

[dcapucho@hotmail.com](mailto:dcapucho@hotmail.com)

**Marcia Brazão e Silva Brandão**

Doctor in Biodiversity and biotechnology, Federal Institute of Education, Science and Technology of Roraima (IFRR)

[marcia.brazao@ifrr.edu.br](mailto:marcia.brazao@ifrr.edu.br)

**Fabiana Granja**

Postdoc in Emerging Viruses, Federal University of Roraima (UFRR)

[fabiana.granja@ufr.br](mailto:fabiana.granja@ufr.br)

## RESUMO

A saúde bucal de pacientes internados em Unidades de Terapia Intensiva (UTI) apresenta desafios específicos, culminando no aumento do risco de infecções nosocomiais. A cavidade oral, comprometida por fatores como sedação profunda e ventilação mecânica, transforma-se em um reservatório de patógenos, favorecendo a aspiração de secreções e a subsequente Pneumonia Associada à Ventilação Mecânica (PAVM). Este artigo, estruturado como uma revisão integrativa da literatura (2020–2025), aprofunda-se: (1) nas particularidades fisiopatológicas da saúde bucal do paciente crítico; (2) no papel do cirurgião-dentista na equipe de UTI; (3) nos mecanismos de resistência antimicrobiana facilitados pelo biofilme oral; e (4) nas evidências sobre a eficácia de protocolos de higiene oral. Conclui-se que a institucionalização de protocolos de higiene oral que incluem a escovação dentária e o uso criterioso de antissépticos (principalmente clorexidina 0,12%) são medidas associadas à redução da incidência de PAVM. É crucial, contudo, considerar a heterogeneidade dos estudos e a necessidade de monitorar desfechos duros como mortalidade e emergência de resistência bacteriana.

**Palavras-chave:** Saúde bucal; UTI; Biofilme; Pneumonia associada à ventilação mecânica; Higiene oral.

## ABSTRACT

The oral health of patients admitted to Intensive Care Units (ICU) presents specific challenges, culminating in an increased risk of nosocomial infections. The oral cavity, compromised by factors such as deep sedation and mechanical ventilation, transforms into a reservoir of pathogens, favoring the aspiration of secretions and subsequent Ventilator-Associated Pneumonia (VAP). This article, structured as an integrative literature review (2020–2025), delves into: (1) the physiopathological particularities of the critical patient's oral health; (2) the role of the dental surgeon in the ICU team; (3) mechanisms of antimicrobial resistance facilitated by oral biofilm; and (4) evidence on the effectiveness of oral hygiene protocols. It is concluded that the institutionalization of oral hygiene protocols including toothbrushing and the judicious use of antiseptics (mainly 0.12% chlorhexidine) are measures associated with the reduction of VAP incidence. However, it is crucial to consider the heterogeneity of studies and the need to monitor hard outcomes such as mortality and the emergence of bacterial resistance.

**Keywords:** Oral health; ICU; Biofilm; Ventilator-associated pneumonia; Oral hygiene.

## RESUMEN

La salud bucal de los pacientes ingresados en Unidades de Cuidados Intensivos (UCI) presenta desafíos específicos que culminan en un aumento del riesgo de infecciones nosocomiales. La cavidad oral, comprometida por factores como la sedación profunda y la ventilación mecánica, se transforma rápidamente en un reservorio de patógenos, favoreciendo la aspiración de secreciones y la subsiguiente Neumonía Asociada a Ventilación Mecánica (NAVM). Este artículo de revisión profundiza en las particularidades fisiopatológicas de la salud bucal del paciente crítico y los mecanismos de colonización orofaríngea, así como en el papel insustituible del cirujano dentista en el equipo de la UCI, detallando sus intervenciones preventivas. Se abordan también los mecanismos de resistencia antimicrobiana facilitados por el biofilm oral y la evidencia más actual sobre la eficacia de protocolos de higiene oral que combinan la remoción mecánica y agentes antisépticos en la reducción de la NAVM. Se concluye que la institucionalización de protocolos rigurosos de higiene oral que incluyen el cepillado dental, supervisado o realizado por un dentista hospitalario, y el uso juicioso de antisépticos (principalmente clorhexidina al 0,12%) son medidas costo-efectivas que reducen drásticamente la incidencia de NAVM. Sin embargo, es crucial que más estudios se centren en el impacto de estas intervenciones en desenlaces como la mortalidad, el tiempo de estancia y la emergencia de resistencia bacteriana.

**Palabras clave:** Salud bucal; UCI; Biofilm; Neumonía asociada a ventilación mecánica; Higiene oral.

## 1. Introduction

Ventilator-Associated Pneumonia (VAP) represents a significant clinical and economic challenge in Intensive Care Units (ICUs) (FU et al., 2023).

Classified as a Healthcare-Associated Infection (HAI), its incidence varies widely, affecting a substantial portion of intubated patients, with high mortality rates that depend on bacterial virulence and pre-existing comorbidities (ZHAO et al., 2020). The predominant pathogenic pathway of VAP is the microaspiration of oropharyngeal secretions colonized by pathogens.

The oral cavity of critically ill patients undergoes dramatic changes under stress conditions and medical interventions. The endotracheal tube acts as a bypass of natural defenses, facilitating the accumulation of secretions in the supraglottic region and the development of biofilm (HUA et al., 2020). This biofilm serves as a constant reservoir of microorganisms that are continuously inoculated into the lower respiratory tract (OYAMAKITA et al., 2024).

Factors such as prolonged sedation and systemic antibiotic therapy alter the normal oropharyngeal flora, favoring dysbiosis and colonization by Gram-negative bacteria (HUANG et al., 2025). In this context, the role of the dental surgeon and the implementation of oral hygiene protocols are pillars of preventive care. Toothbrushing and the use of antiseptics, when performed according to protocol, have demonstrated efficacy in reducing VAP incidence (FU et al., 2023).

This article proposes an integrative review of recent evidence (2020–2025) regarding oral health in patients under mechanical ventilation, analyzing pathophysiological mechanisms, the role of the hospital dentist, and the comparative efficacy of oral hygiene interventions.

## 2. Material and Methods

This is an integrative literature review, a method that allows for the synthesis of multiple published studies and enables general conclusions regarding a particular area of study (SOUZA et al., 2010). The search was conducted in the PubMed/MEDLINE, LILACS, and Cochrane Library databases, strictly covering the period from January 2020 to December 2025.

The following controlled descriptors (DeCS/MeSH) were used: "Pneumonia, Ventilator-Associated", "Oral Hygiene", "Dental Plaque", and "Intensive Care Units", combined using the Boolean operator AND. Inclusion criteria were randomized clinical trials, systematic reviews, meta-analyses, and clinical guidelines available in full text. Animal studies, isolated case reports, and articles that did not directly address the interface between oral health and mechanical ventilation were excluded.

### 3. Literature Review

#### 3.1 Oral Health of the Inpatient: Particularities and Colonization

Sedation and pharmacological coma suppress essential protective reflexes, such as coughing and swallowing. This suppression leads to secretion stasis and biofilm accumulation, creating an ideal environment for bacterial proliferation (VALENTIM et al., 2022). Orotracheal intubation promotes the leakage of contaminated secretions around the tube cuff into the trachea. Studies demonstrate that the oral flora of these patients is rapidly replaced by Gram-negative pathogens and yeasts (ZHAO et al., 2020).

Xerostomia is a common complication, exacerbated by medications and fluid management. The decrease in salivary production eliminates the host's primary defense (immunoglobulins and mechanical clearance), accelerating biofilm formation (GOMES et al., 2025). Additionally, the presence of pre-existing periodontal disease acts as a gateway for systemic inflammation and a reservoir for pathogens (ALVES; MAGALHÃES, 2023).

#### 3.2 Oral Biofilm: Reservoir and Aspiration

Mature oral biofilm is a matrix rich in microorganisms. Recent reviews establish a strong link between lack of oral hygiene and VAP incidence. A 2023 meta-analysis by Fu et al. found that interventions including toothbrushing associated with chlorhexidine reduced VAP incidence (OR 0.63; 95% CI 0.43-0.91). This reinforces that mechanical disruption of the biofilm is crucial, as the Extracellular Polymeric Matrix (EPS) functions as a physical and ionic barrier that hinders chlorhexidine penetration into deeper layers (VERÍSSIMO et al., 2021). This incomplete penetration exposes bacteria to sub-lethal concentrations of the antiseptic, creating an ideal scenario for bacterial adaptation.

#### 3.3 Impact on Clinical Outcomes: Cost and Mortality

VAP increases the length of stay in the ICU, the duration of mechanical ventilation, and the use of broad-spectrum antimicrobials (ZHAO et al., 2020). The implementation of effective protocols has the potential to reduce these times and generate cost savings (HUA et al., 2020).

However, it is essential to interpret the data with caution: a reduction in VAP incidence does not automatically translate into a reduction in mortality. The Cochrane review (HUA et al., 2020) indicates low certainty of evidence regarding the reduction of overall mortality (RR 0.84). Updated data from the SHEA/IDSA guidelines (KLOMPAS et al., 2022) corroborate that while oral hygiene improves the quality of care, a direct association with mortality reduction remains difficult to prove due to multiple confounding factors in critically ill patients.

### **3.4 The Role of the Dental Surgeon and Standardization of Protocols**

The dental surgeon acts in risk assessment, diagnosis, and the resolution of infectious foci. While seminal studies (Bellissimo-Rodrigues et al., 2014) established the basis for this role, recent evidence from Aljohani et al. (2023) reinforces that the presence of a protocol supervised by dental professionals significantly improves nursing team adherence and the quality of mechanical cleaning.

Their critical role lies in the mechanical removal of biofilm and the standardization of protocols. The dentist leads the creation of checklists and team training (COSTA et al., 2022). Furthermore, the management of soft tissue lesions and orofacial pain control are competencies that ensure comfort and prevent new portals of entry for infections (FONSECA et al., 2022).

### 3.5 Antimicrobials, Safety, and Bacterial Resistance

The structural nature of oral biofilm hinders antimicrobial penetration. Chlorhexidine (CHX) is the gold-standard antiseptic, but its use is not without risks. Local adverse effects, such as oral mucosal desquamation and tooth staining, have been reported (HUA et al., 2020).

More concerning is the potential for resistance. Recent studies indicate that exposure to CHX can select for strains harboring efflux pump genes (such as *qacA/B*), conferring cross-resistance to vital antibiotics (ALJOHANI et al., 2023). Although 0.12% CHX is effective, the risk of inducing resistance in ICUs with a high prevalence of multidrug-resistant microorganisms requires judicious use (CCIH, 2025). Alternatives such as octenidine and hydrogen peroxide are being studied to mitigate this risk, although their use still requires robust validation (HUANG et al., 2025).

### 3.6 Heterogeneity of Studies and Diagnosis

The interpretation of evidence is hampered by diagnostic heterogeneity. The updated SHEA/IDSA prevention strategies highlight that the definition of VAP varies between subjective and objective criteria (KLOMPAS et al., 2022). This variability can distort the perceived efficacy of interventions.

To systematize protocol variability and facilitate the visualization of the strength of recommendations, Table 1 summarizes the main interventions, frequencies, and evidence levels of the include studies.

Table 1. Synthesis of Oral Hygiene Interventions, Protocols, and Level of **Evidence**.

Author(s) / Year	Study Design	Focus Intervention	/	Main Findings	Evidence Level*
<b>CLINICAL EFFICACY AND VAP PREVENTION</b>					
Hua et al. (2020)	Systematic Review (Cochrane)	Use of Chlorhexidine (CHX)		High evidence for VAP reduction; Low for mortality.	1A
Fu et al. (2023)	Meta-analysis	Toothbrushing CHX vs. CHX	+	The combination (Brushing + CHX) significantly reduced VAP (OR 0.63).	1A
Oyamakita et al. (2024)	Network Meta-analysis	Comparison methods	of	Brushing + 0.12% CHX had an 88.4% probability of being the best intervention.	1A
Oikawa et al. (2025)	Meta-analysis	Antiseptics Pediatrics	in	No significant benefit of antiseptics in children (RR 0.95).	1A
<b>ANTIMICROBIAL RESISTANCE AND MICROBIOME</b>					
Tartor et al. (2025)	Cross-sectional / Molecular Study	Efflux Genes Nosocomials	in	High prevalence of efflux genes ( <i>qacA/B</i> , <i>cepA</i> ) in CHX-resistant <i>K. pneumoniae</i> and <i>S. aureus</i> .	4
Neubauer et al. (2025)	Genomics / Transcriptomics	Adaptation of <i>Streptococcus</i>	of	CHX exposure induces up-regulation of transport (efflux) genes, generating rapid tolerance.	5
Brochado et al. (2024)	Clinical Trial / Metagenomics	Oral Microbiome		CHX use alters oral diversity and increases the relative abundance of antimicrobial resistance genes.	2B
Opoku-Temeng et al. (2023)	Review	Cross-Resistance		Confirms the link between CHX tolerance and cross-resistance to antibiotics (e.g., Colistin).	5
Auer et al. (2022)	In Vitro Study	Adaptation of <i>S. mutans</i>	of	Adaptation to CHX resulted in cross-resistance to Daptomycin (last-resort antibiotic).	5
Bescos et al. (2020)	Clinical Study	Oral Physiology		CHX increases oral acidity and reduces nitrate-reducing bacteria, impacting systemic health.	2B
Mao et al. (2020)	Review	Quaternary Compounds		Warning regarding cross-resistance between biocides (QACs) and critical ICU antibiotics.	5

\*Legend: 1A: Syst. Review of RCTs; 1B: Individual RCT; 2B: Cohort Study; 4: Case Series/Cross-sectional; 5: Opinion/Narrative Review.

The analysis of Table 1 reveals an important dichotomy in contemporary literature (2020–2025): while the clinical efficacy of chlorhexidine in reducing VAP incidence is robust – especially when combined with toothbrushing, resulting in an approximately 37% relative reduction in the odds of developing VAP—there is a growing body of evidence warning of the biological cost of this intervention regarding antimicrobial resistance. (FU et al., 2023; OYAMAKITA et al., 2024)

Recent molecular studies unravel the mechanisms of this resistance. Neubauer et al. (2025) demonstrated, via transcriptomic analysis, that chlorhexidine exposure rapidly induces the up-regulation of membrane transport genes in *Streptococcus spp.*, facilitating drug expulsion. This is clinically corroborated by Tartor et al. (2025), who identified a higher prevalence of efflux pump genes (such as *qacA/B* and *cepA*) in nosocomial isolates of *K. pneumoniae* and *S. aureus*, suggesting that routine biocide use in the ICU may be selecting for resilient pathogens.

The direct clinical implication is the phenomenon of cross-resistance. Auer et al. (2022) and Mao et al. (2020) warn that adaptation to chlorhexidine may confer cross-protection against last-resort antibiotics, such as Daptomycin and Colistin. Furthermore, Brochado et al. (2024) observed that chlorhexidine mouthwashes not only alter the diversity of the oral microbiome (dysbiosis) but also increase the relative abundance of resistance genes in the remaining biofilm.

Oyamakita et al. (2024) corroborate that toothbrushing combined with 0.12% chlorhexidine is the current "gold standard" intervention for adults. However, Oikawa et al. (2025) shed light on the pediatric population, where the use of antiseptics showed no benefit (RR 0.95), suggesting that in children, the focus should be strictly mechanical to avoid toxicity.

Another frequently neglected safety aspect is the physiological impact. Bescos et al. (2020) demonstrated that chlorhexidine eliminates nitrate-reducing bacteria on the tongue dorsum, leading to oral pH acidification and a potential impact on systemic blood pressure due to the disruption of the entero-salivary nitrate cycle.

Finally, mortality analysis remains a point of caution. Both Hua et al. (2020) and Klompas et al. (2022) agree that while oral hygiene prevents infection, decreases length of stay, and reduces subsequent antimicrobial use, there is no robust evidence that it saves lives in isolation. This reinforces the need to view it as an essential part of a multidisciplinary bundle rather than a standalone solution.

#### 4. Final Considerations

Oral health in ICU patients is a determining factor for VAP prevention. Evidence from 2020 to 2025 confirms that rigorous management of the oral cavity is indispensable. Combined interventions (mechanical brushing + antiseptics) are the most effective for adults. The dental surgeon is fundamental to ensuring proper technique and adherence to protocols. The immediate implementation of these practices is recommended, with caution regarding the pediatric use of antiseptics and continuous monitoring of bacterial resistance.

#### References

ALJOHANI, A. A. et al. The impact of oral care on ventilator-associated pneumonia in intensive care units: a retrospective study. **J. Infect. Public Health**, v. 16, n. 4, p. 555-561, 2023.

ALVES, B. S.; MAGALHÃES, J. M. I. Analysis of oral care for the prevention of pneumonia associated with mechanical ventilation in patients intubated in the intensive care unit: an integrative review of the literature. **Res. Soc. Dev.**, v. 12, n. 13, p. e45121344209, 2023.

AUER, A. et al. Adaptation of *Streptococcus mutans* to Chlorhexidine and its implications for cross-resistance. **Antimicrob. Agents Chemother.**, v. 66, n. 8, p. e00456-22, 2022.

BESCOS, R. et al. Effects of Chlorhexidine mouthwash on the oral microbiome. **Sci. Rep.**, v. 10, n. 1, p. 5254, 2020.

BROCHADO, I. et al. Chlorhexidine digluconate mouthwash alters the oral microbial composition and affects the prevalence of antimicrobial resistance genes. **Front. Microbiol.**, v. 15, p. 1429692, 2024.

CCIH. **Clorexidina oral mata ou previne PAV?** São Paulo: Instituto CCIH+, 2025. Disponível em: <https://www.ccih.med.br/clorexidina-oral-mata-ou-previne-pav/>. Accessed on: 2 jan. 2026.

COSTA, R. F. et al. Protocolos de higiene bucal em unidades de terapia intensiva: uma revisão sistemática. **Rev. Bras. Odontol. Hosp.**, v. 8, n. 1, p. 45-52, 2022.

FONSECA, A. B. A. et al. Protocolos utilizados para higienização bucal de pacientes em UTI: uma revisão integrativa. **Rev. Bras. Odontol. Hosp.**, v. 9, n. 2, 2022.

FU, L.-S. et al. Impact of oral care modalities on the incidence of ventilator-associated pneumonia in the intensive care unit: a meta-analysis. **Medicine (Baltimore)**, v. 102, n. 13, p. e33418, 2023.

GOMES, J. N. M. et al. Controle do biofilme bucal na odontologia hospitalar para prevenção de pneumonia associada à ventilação mecânica. **Rev. Acervo Mais**, v. 6, n. 1, p. e19640, 2025.

HUA, F. et al. Oral hygiene care for critically ill patients to prevent ventilator-associated pneumonia. **Cochrane Database Syst. Rev.**, n. 10, p. CD008367, 2020.

HUANG, H. et al. Oral care medications for the prevention and treatment of ventilator-associated pneumonia in intensive care unit. **Front. Oral Health**, v. 6, 2025.

KLOMPAS, M. et al. Strategies to prevent ventilator-associated pneumonia, ventilator-associated events, and nonventilator hospital-acquired pneumonia in acute-care hospitals: 2022 Update. **Infect. Control Hosp. Epidemiol.**, v. 43, n. 6, p. 687-713, 2022.

MAO, X. et al. Quaternary ammonium compounds: Cross-resistance and clinical implications. **J. Glob. Antimicrob. Resist.**, v. 23, p. 308-312, 2020.

NEUBAUER, M. et al. Genomic and transcriptomic adaptation to Chlorhexidine in *Streptococcus* spp. **Front. Cell. Infect. Microbiol.**, v. 14, p. 1217103, 2025.

OIKAWA, H. et al. A systematic review and meta-analysis: oral hygiene procedures using antiseptics showed no significant difference in preventing VAP. **J. Hosp. Infect.**, 2025.

OPOKU-TEMENG, C. et al. Chlorhexidine resistance or cross-resistance, that is the question. **Antibiotics (Basel)**, v. 12, n. 5, p. 798, 2023.

OYAMAKITA, S. et al. Comparative efficacy of various oral hygiene care methods in preventing ventilator-associated pneumonia in critically ill patients: a systematic review and network meta-analysis. **PLoS One**, v. 19, n. 12, p. e0313057, 2024.

SOUZA, M. T.; SILVA, M. D.; CARVALHO, R. Integrative review: what is it? How to do it? **Einstein (Sao Paulo)**, v. 8, n. 1, p. 102-106, 2010.

TARTOR, Y. H. et al. Nosocomial *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, and *Staphylococcus aureus*: sensitivity to Chlorhexidine-based biocides and prevalence of efflux pump genes. **Int. J. Mol. Sci.**, v. 26, n. 1, p. 355, 2025.

VALENTIM, N. R. V. S.; TAKASHI, M. H.; CARVALHO, M. R. Eficácia da Clorexidina na higiene bucal para prevenção de pneumonia associada a ventilação mecânica. **REVISA (Braz. J. Health)**, v. 11, n. 3, p. 314–325, 2022.

VERÍSSIMO, G. S. L. et al. Biofilme: mecanismo de virulência bacteriana. **Rev. Multidiscip. Saude**, v. 2, n. 3, p. 91, 2021.

ZHAO, Y. et al. Oral hygiene care for critically ill patients to prevent ventilator-associated pneumonia: a randomized controlled trial. **J. Hosp. Infect.**, v. 104, n. 4, p. 434-440, 2020.