

# Oral condition of critical patients and its correlation with ventilator-associated pneumonia: a pilot study

*Condição oral de pacientes críticos e sua correlação com pneumonia associada a ventilação mecânica: um estudo piloto*

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## Resumo

**Introdução:** A literatura vem relatando condições inadequadas de higiene oral de pacientes em unidade de terapia intensiva (UTI) e a ocorrência de Pneumonia associada à ventilação mecânica em cerca de 9%-27% de todos os pacientes intubados. **Objetivo:** O objetivo deste estudo foi avaliar condições orais de pacientes críticos e correlacionar com a presença de pneumonia associada à ventilação mecânica. **Material e método:** Vinte e três pacientes foram categorizados da seguinte maneira: com a doença periodontal e com pneumonia associada à ventilação mecânica, com doença periodontal e sem pneumonia associada à ventilação mecânica, sem doença periodontal e com pneumonia associada à ventilação mecânica e sem doença periodontal e sem pneumonia associada à ventilação mecânica. Foram utilizados na avaliação os índices de placa, de doença periodontal e índice de cariados, perdidos e obturados. **Resultado:** Não houve diferença estatisticamente significativa na incidência da doença periodontal em relação à pneumonia associada à ventilação mecânica, mas o número de dentes e superfícies com perda de inserção acima de 4 mm sempre foi maior em pacientes com pneumonia associada à ventilação mecânica. **Conclusão:** A extensão da doença periodontal pode contribuir para o aparecimento de pneumonia associada à ventilação mecânica. No entanto, são necessários estudos com uma amostra maior para validar essa relação.

**Descritores:** Placa dentária; unidade de terapia intensiva; infecção hospitalar; saúde bucal; doenças periodontais.

## Abstract

**Introduction:** Literature has reported inadequate oral hygiene conditions in Intensive Care Unit (ICU) patients and the occurrence of Ventilator-associated pneumonia in about 9%-27% of all intubated patients. **Objective:** The aim of this study was to evaluate ICU patient's oral conditions and correlate this with the presence of ventilator-associated pneumonia. **Material and method:** Twenty-three patients were categorized in the following way: with periodontal disease and ventilator-associated pneumonia, with periodontal disease and without ventilator-associated pneumonia, without periodontal disease and with ventilator-associated pneumonia, and with neither periodontal disease nor ventilator-associated pneumonia. The periodontal disease index, plaque index, and decay-missing-filled index were used in the assessment. **Result:** There was no statistically significant difference in the incidence of periodontal disease with respect to ventilator-associated pneumonia, but the number of teeth and surfaces with attachment loss above 4 mm was always greater in patients with ventilator-associated pneumonia. **Conclusion:** The extent of periodontal disease may contribute to the onset of ventilator-associated pneumonia. However, studies with a larger sample are needed to validate this relationship.

**Descriptors:** Dental plaque; intensive care units; cross infections; oral health; periodontal diseases.

## INTRODUCTION

While infection is a frequent manifestation in intensive care unit (ICU) patients, the risk of oral-cavity infection should also be considered. The mouth is considered an ideal microbial incubator because of its characteristic oxygen tension, pH, and the presence of nutrients. In addition, the hard surfaces in the mouth such as enamel, cementum, restorations, prostheses, and implants, favor the development of microbial deposits leading to the formation of dental biofilm<sup>1</sup>.

Literature has reported inadequate oral hygiene conditions in ICU patients. Researchers have agreed that oral biofilm could be colonized by respiratory pathogens and that microorganisms associated with nosocomial pneumonia originate from the mouth<sup>2,3</sup>. Additionally, caries and periodontal disease are infectious diseases present in the mouth that affect a significant number of individuals, with periodontal disease reaching a prevalence of 50% in the Brazilian population<sup>4</sup>. Thus, the presence of these poor oral conditions can endanger individuals who enter ICUs<sup>5,6</sup>.

Individuals who are admitted to a hospital environment are often critical. Their immune response may be compromised; as a result, latent infections intensify. Poor oral hygiene can aggravate a pre-existing oral condition or contribute to the development of fungal or viral opportunistic infections such as oral candidiasis<sup>6</sup>. In addition, the use of medicines for these patients may change the amount of saliva produced. This can lead to hyposalivation, which in turn favors the deposition of organic matter and significantly increases biofilm deposition around the teeth, back of the tongue, and throughout the mouth. Another important factor is intubation, which causes the patient to remain open-mouthed, a condition that generates greater dehydration of buccal mucosa. This increases the predisposition to ulcerations and facilitates the colonization of respiratory pathogens by biofilm originating from the hospital environment. All of these factors increase the risk of oral infections and may compromise the patient's prognosis<sup>2,3,7</sup>.

The relationship between periodontal disease and systemic conditions, including lung infections, has not been thoroughly explored. If periodontal disease does not necessarily lead to an increase in respiratory illnesses, it is believed that it can at least lead to a change in the normal behavior of these diseases. As the presence of periodontal infection causes changes in indigenous bacteria from the oral cavity, one can hypothesize that diseases resulting from oral microaspirations differ, from a microbiological point of view, from the diseases that occur in people with normal oral microbiota<sup>6,7</sup>.

Nosocomial pneumonia is an infection and inflammation of the lung with consolidation and exudation that pertains to or originates in a hospital<sup>8</sup>. Ventilator-associated pneumonia (VAP) is the type that occurs between 48 and 72 h after intubation and initiation of mechanical ventilation<sup>8,9</sup>. VAP occurs in about 9%-27% of all intubated patients<sup>10</sup>.

Thus, the aim of this study was to assess the oral condition of patients in an ICU and analyze the data with respect to the presence of VAP.

## MATERIAL AND METHOD

This study was submitted and approved by the Committee of Ethics in Research Involving Human Subjects with protocol number 009/2010-PH/CEP.

Twenty-three patients admitted to the ICU of the Hospital viValle, in São José dos Campos, State of São Paulo, Brazil, were assessed from August 2010 to May 2011 (9 months). The patients were categorized into the following groups:

- Individuals with periodontal disease and with ventilator-associated pneumonia (PD + VAP);
- Individuals with periodontal disease and without ventilator-associated pneumonia (PD + NVAP);
- Individuals without periodontal disease and with ventilator-associated pneumonia (NPD + VAP);
- Individuals with neither periodontal disease nor ventilator-associated pneumonia (NPD + NVAP).

To participate in the study, patients had their "free and informed consent" form signed by their legal representative.

### Inclusion criteria:

- age between 18 and 75 years;
- patients under mechanical ventilation (intubated or with endotracheal tube) for more than 48 h.

### Exclusion criteria:

- patients with severe maxillofacial trauma that eliminates the possibility of examination, or edentulous patients;
- immunosuppressed patients;
- patients who have not received authorization from the ICU medical staff of the Hospital viValle or its legal representative for the oral examination;
- compromised oral examination owing to the presence of the endotracheal tube.

Antibiotic usage (if applicable) and the time from intubation to examination date were recorded for all patients.

The evaluation of the periodontal condition was assessed by using the periodontal disease index (PDI)<sup>11</sup>; Turesky et al.'s plaque index (PI)<sup>12</sup>; and the decayed, missing, and filled teeth (DMF) index<sup>13</sup>.

The examinations were performed by a previously calibrated examiner that obtained an intraclass correlation coefficient (ICC) of 0.8685 (0.8338-0.8959) ( $P < 0.005$ ).

With respect to the provision of oral care, currently admitted patients in the ICU at Hospital viValle were cared for by teams of nurses and physiotherapists. Oropharyngeal-tract mucus was aspirated twice a day by physiotherapists, and chlorhexidine 2% was topically applied twice a day by the nursing staff.

Patient data with respect to the presence of VAP were also evaluated. Patients were classified as individuals with respiratory tract infections through the diagnosis of ICU medical staff from the Hospital viValle. The diagnosis of VAP followed the criteria of the CDC (Centers for Disease Control and Prevention) established by the NNIS (National Nosocomial Infection Surveillance System), which were applied by the hospital infection control team at Hospital viValle as part of routine patient care intensive therapy.

Therefore, while this routine complements the study, it is not an integral part of the present research protocol (this practice is already a part of routine patient care and was conducted independently of this study).

After collection of patient data, patients were categorized according to the dependent variable, VAP (i.e., with or without the presence of VAP). Statistical analyses were performed by chi-square test, Fisher's exact test, and Mann-Whitney test to compare independent variables for each group, and logistic regression to test the association between the dependent and independent variables.

## RESULT

The PDI, PI, and DMF indices were assessed in 23 patients intubated for more than 48 h in our hospital's ICU. The demographic data of the analyzed patients are presented in Table 1.

Table 2 presents the periodontal condition of patients, categorized according to the dependent variable in the study—the presence of VAP. When the frequency of the presence or absence of periodontal disease was examined in relation to the presence of VAP, there was no statistically significant difference. However, the results showed that the extent of the disease could be a factor that may influence the onset of VAP. The difference between the groups in relation to the frequency of surfaces with attachment loss above 4 mm was 0.06. In addition, the number of teeth and surfaces with attachment loss above 4 mm was always greater in the group of patients with VAP, and the difference is statistically significant for both parameters ( $P = 0.034$  and  $0.041$ , respectively).

**Table 1.** Demographic data of the individuals included in the survey (N = 23)

	Without VAP		With VAP		P value
	N	%	N	%	
<b>Sex</b>					85.7
Men	13	82	6		
Women	3	18	1		14.3
<b>Age (years)</b>	51.62 ± 14.0		56.28 ± 10.85		<0.46
<b>ICU length of stay (days)</b>	10.6 ± 6.89		13.57 ± 7.24		<0.39

Evaluation of normality by Shapiro-Wilk, statistically significant difference by *t* test.

**Table 2.** Association between periodontal disease and presence of VAP

	Respiratory condition				P value	OR (95% CI)
	Without VAP		With VAP			
	N	%	N	%		
<b>Periodontal disease</b>					<0.9	
Yes	12	75	6	85.7		
No	4	25	1	14.3		
Medium value of PDI	3.67 ± 1.1		3.98 ± 0.84		0.47	
<b>Extent of the disease by tooth</b>					0.6	
Subjects with more than 4 teeth with attachment loss > 4 mm	3	18	2	28.5		
Subjects with less than 4 teeth with attachment loss > 4 mm	13	82	5	71.5		
Average of number of teeth with attachment loss > 4 mm	1.43 ± 0.9		2.83 ± 0.89		0.034**	
<b>Extent of the disease by surfaces</b>					0.06	0.01–0.98
Subjects with more than 5 surfaces with attachment loss > 4 mm	4	25	5	71.5		
Subjects with less than 5 surfaces with attachment loss > 4 mm	12	75	2	28.5		
Average of number of surfaces with attachment loss > 4 mm	3.62 ± 2.1		6.33 ± 1.9		0.041**	
Medium value of PI	1.77 ± 0.6		2.33 ± 1.2		0.4	

$\chi^2$  test; \*Fisher's exact test; \*\*Mann-Whitney test; OR: odds ratio; PDI = periodontal disease index; PI = plaque index.

Table 3 presents the condition of dental caries (DMF) in patients, categorized according to the presence of VAP. The average value of the DMF index for patients with VAP was  $19.28 \pm 6.3$  and in patients without VAP was  $19.81 \pm 7.8$  ( $P > 0.05$ ). In addition, the difference in the frequency of teeth with dental caries was not statistically significant;  $1.68 \pm 2.8$  teeth for the group without VAP and  $1.66 \pm 2.9$  for the group with VAP ( $P > 0.05$ ).

Logistic regression analysis did not detect a positive association or statistically significant difference between the various independent variables and the dependent variable (i.e., the presence or absence of VAP).

## DISCUSSION

Literature is controversial regarding the association of VAP and periodontal disease. Most of the studies were conducted in populations with a high prevalence of pneumonia, such as hospitalized patients and the elderly in nursing homes.

Scannapieco et al.<sup>14</sup> (1998), in an epidemiological study, found no association between the periodontal status or poor oral hygiene and acute respiratory disease, but reported that there is evidence to support the role of bacteria and/or deficient oral health in the pathogenesis of nosocomial pneumonia. Poor dental health, dental plaque, and bacterial colonization of the oropharynx have been associated with the occurrence of pneumonia in hospitalized patients or in the ICU<sup>2,15-19</sup>, but a clear relationship between periodontitis and pneumonia has not always been found<sup>20,21</sup>.

In our study, we examined 23 individuals who were admitted to the ICU and intubated. When the frequency of the presence or absence of periodontal disease in relation to the presence of VAP was analyzed, we did not find a statistically significant association. However, the presence or absence of periodontal disease is not a rigorously objective criterion, since varying degrees of severity and extent of illness can be found. Thus, a further analysis was carried out, looking to assess the degree of disease in the presence or absence of VAP. When we analyzed the extent of the disease, we observed that the frequency of surfaces with attachment loss over 4 mm was greater in the group with VAP ( $P = 0.06$ ), and

there was a statistically significant difference for the 2 parameters ( $P = 0.034$  and  $0.041$ , respectively).

Despite not having observed a statistically significant positive association in regression analysis in the present study, these data may suggest that in larger case-control or cohort studies, the association between periodontal disease and VAP can be proven.

These data corroborate the study by Sharma, Shamsuddin<sup>22</sup> (2011), who evaluated patients hospitalized with respiratory disease (test group) and patients who were systemically healthy (control group). They showed that the greatest probing depths and the greatest values of attachment loss were associated with respiratory disease; specifically, higher degrees of periodontal involvement may increase the risk of pneumonia for hospitalized individuals.

One possible explanation for this is the fact that the patients with the greatest extent of periodontal disease harbor a greater quantity of pathogenic microorganisms. However, these results should be interpreted with caution, since the sample of this study is limited and larger studies and microbiological evaluations should be carried out.

Average values for PDI were  $3.98 \pm 0.84$  for individuals with VAP and  $3.67 \pm 1.1$  for individuals without VAP. These data seem to reflect "moderate periodontitis," according to the classification of the *American Academy of Periodontology* (AAP) where the severity of chronic periodontitis corresponds with attachment losses between 3 and 4 mm<sup>23</sup>. Thus, the extent of the disease may be a factor that influences the onset of pneumonia.

For the diagnosis of periodontitis, a complete periodontal examination is ideal, using the attachment level associated with a periapical radiographic examination as a parameter. However, the position of the tube, presence of too much secretion in the oral cavity, difficulty in opening the mouth, and reduced time of contact with the patient often meant more detailed examinations.

In view of these circumstances, the PDI was chosen, as it uses the measure of attachment loss as a parameter of the definition of periodontitis in these teeth: 16, 21, 24, 36, 41, and 44. Despite being a simplified index, it is reliable in detecting the presence of attachment loss.

**Table 3.** Association between DMF index and presence of VAP

	Respiratory condition					
	Without VAP		With VAP		P value	OR (95%)
	N	%	N	%		
Medium value of DMF	$19.81 \pm 7.8$		$19.28 \pm 6.3$		<0.8	
<b>Extent of caries disease</b>					<0.9	
Subjects with more than 2 teeth with dental caries	4	25	2	28.5		
Subjects with less than 2 teeth with dental caries	12	75	5	71.5		
Average of number of teeth with dental caries	$1.68 \pm 2.8$		$1.66 \pm 2.9$		0.8	

\*Fisher's exact test; \*\*Mann-Whitney test; OR: odds ratio.

However, recent studies<sup>24</sup> showed that partial exams like the Ramfjord index (PDI) tend to underestimate the extent of periodontal disease. Therefore, future studies that seek to evaluate the influence of periodontal diseases on VAP should conduct a whole mouth assessment.

Systematic reviews have shown a link between poor oral health and pneumonia<sup>25,26</sup>. Aspiration of periodontal pathogens and bacteria associated with dental caries in dental plaque and saliva has been considered a risk factor for pneumonia in elderly patients in asylums<sup>27,28</sup>, a fact that supports the use of the DMF index.

In the present study, the medium value of the DMF index of patients with VAP was  $19.28 \pm 6.3$ , and in patients without VAP was  $19.81 \pm 7.8$  ( $P > 0.05$ ). In addition, the frequency of teeth with dental caries did not have a statistically significant association with VAP. The frequency was  $1.68 \pm 2.8$  teeth for the group without VAP and  $1.66 \pm 2.9$  for the group with VAP ( $P > 0.05$ ). These values reflect an adult population with missing teeth (lost), dental caries, teeth with prosthetic treatment, and several restored teeth.

This index was also used by Fourrier et al.<sup>29</sup> (2005) for the evaluation of dental status, because of its recommendation by the WHO and the International Dental Federation. The authors studied the effect of decontamination with chlorhexidine 0.2% gel in patients with nosocomial infection acquired in an ICU. The study was double blinded. In the study group, the DMF medium was  $19.0 \pm 8.8$ , and in the placebo group, it was  $20.2 \pm 8.6$ . The data from this study are in agreement and corroborate the results

of Bourgeois et al.<sup>30</sup> (1999), who evaluated the dental status of an adult population in France.

In this study, it was observed that there was no significant difference between patients with VAP and without VAP in relation to the PI.

Sharma, Shamsuddin<sup>22</sup> (2011) also reported that patients with respiratory illness had much worse periodontal conditions than did healthy control group patients, when the PI and gingival index were evaluated. The lack of a statistically significant difference in the plaque index in the present study is probably because there is an oral hygiene protocol for ICU patients. This may increase the strength of periodontal disease as a risk factor for VAP.

## CONCLUSION

Within the limitations of the study, we can conclude that the extent of periodontal disease may be a factor that contributes to the onset of VAP. However, studies with a larger sample are needed to validate this relationship.

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## CONFLICTS OF INTERESTS

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The authors declare no conflicts of interest.

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