

Effect of Octenidine Dihydrochloride on Gingival Inflammation, Dental Plaque, and Xerostomia in Patients Receiving Respiratory Support

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For citation: Irina A. Ruslyakova, Ekaterina A. Zakharova, Yulia A. Mironova, Ilja S. Chertsov, Elvina Z. Shamsutdinova, Alexey V. Silin. Effect of Octenidine Dihydrochloride on Gingival Inflammation, Dental Plaque, and Xerostomia in Patients Receiving Respiratory Support. *Obshchaya Reanimatologiya = General Reanimatology*. 2026; 22 (4): 28–37. <https://doi.org/10.15360/1813-9779-2026-4-2650> [In Russ. and Engl.]

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Summary

Maintaining oral hygiene in patients receiving respiratory support is critically important for preventing healthcare-associated infections.

The aim of the study was to evaluate the clinical effect of octenidine dihydrochloride mouthwash added to local oral hygiene care protocol for patients receiving respiratory support.

Materials and Methods. This prospective cohort study included 299 patients receiving respiratory support in the ICU setting during 2023–2026 years; after propensity score matching (PSM), 208 (104 pairs) patients were included in the final analysis. Oral hygiene protocol included twice-daily tooth brushing and oral rinsing at a frequency determined by the Intensive Care Oral Care Frequency Assessment Scale (ICOCFAS). Octenidine dihydrochloride 0.1% solution was used as the rinse in the study group, and distilled water — in the control group. A dentist assessed oral health using the Challacombe Scale of Clinical Oral Dryness (CSCOD), Plaque Index (PI), and Modified Gingival Index (MGI) at predefined time points.

Results. During days 1–3, the study group showed a decrease in the median MGI and PI values compared with the control group ($p < 0.001$). By day 7, the favorable changes in the MGI and PI in the study group had boosted, and between-group differences remained significant ($p < 0.001$). The effect of the intervention did not depend on the clinical outcome: the «group × outcome» interaction was not statistically significant for ΔMGI_{1-3} and ΔMGI_{1-7} ($p = 0.269$ and $p = 0.141$, respectively). Changes in xerostomia (CSCOD) did not differ significantly between the groups ($p = 0.119$).

Conclusion. The use of 0.1% octenidine dihydrochloride mouthwash as a part of the oral hygiene protocol in patients receiving respiratory support results in rapid resolution of gingival inflammation (MGI) and effective removal of dental plaque (PI). However, the persisting rigidity of xerostomia (CSCOD) regardless of the hygiene care protocol warrants searching for additional correction strategies.

Keywords: octenidine dihydrochloride; gingival inflammation; dental plaque; xerostomia; modified gingival index; oral hygiene; respiratory support

Conflict of interest. The authors declare no conflict of interest.

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Introduction

Oral hygiene is a cornerstone of the prevention of healthcare-associated infections [1–3]. In critically ill patients receiving respiratory support, the risk of developing and progressing plaque-induced gingivitis increases substantially because of reduced salivary flow, insufficient scope of hygiene measures, and the prolonged persistence of opportunistic microflora within the biofilm. Each type of respiratory support adds its own risk factors. For example, with mechanical ventilation (MV), additional threats include traumatic injury to the mucosa from the endotracheal

tube and nasogastric tube [4, 5], as well as increased accumulation of plaque on the chewing surfaces of the molars. In noninvasive ventilation (NIV), mask design interferes with thorough oral cavity care [5]. In contrast, high-flow oxygen therapy (HFOT) has a dual effect: in nasal breathing adequate humidification and warming of the gas provide protection of the mucosa, whereas high flow in mouth breathing promotes xerostomia and damage to the epithelial barrier. In addition, in all patients receiving respiratory support, regardless of the modality, prosthodontic appliances (fixed and removable dentures) play an

important role by creating additional retention sites for microbial colonization [6].

Mechanical removal of dental plaque and irrigation (rinsing) are well established basic methods of maintaining oral hygiene [7]. Various solutions are used for oral irrigation in the ICU: povidone-iodine, sodium bicarbonate, tap water, chlorhexidine, herbal extracts, and antibiotics in toothpaste formulations [8–10]. According to Amrita et al., octenidine dihydrochloride is superior to 0.2% chlorhexidine solution in antimicrobial activity, effectiveness in reducing periodontal inflammation, and plaque control [11]. In a study by Sabantseva et al., it was shown that a seven-day course of a mouth rinsing with 0.1% octenidine dihydrochloride solution associated not only with a reduction in pathogenic and atypical oral microorganisms, but also with a lower incidence or less severity of oral dysbiosis [12].

In clinical practice, there remains considerable variability in approaches to oral assessment and heterogeneity in the protocols used, which is associated with the lack of consensus among professional organizations [13, 14]. Scales used in ICU oral hygiene protocols, such as the Beck Oral Assessment Score (BOAS) and the Intensive Care Oral Care Frequency Assessment Scale (ICOCFAS), regulate the frequency of oral care [15, 16]. To quantitatively assess the effectiveness of hygiene interventions in clinical practice, validated dental indices are used: Lobene or Modified Gingival Index (MGI), Gingival Bleeding Index (GBI), Papillary Bleeding Index (PIBI/Mazza PIBI), Plaque Index (PI), Mucosal-Plaque Score (MPS), Turesky Quigley-Hein plaque index (TQHPi), as well as the Challacombe Scale of Clinical Oral Dryness (CSCOD) [17–20].

Thus, to date, there are no data on the clinical efficacy of including a 0.1% octenidine dihydrochloride solution in a local oral hygiene care protocol for patients receiving respiratory support. In addition, the available literature does not describe any objective assessment of the outcomes of such interventions using validated dental indices.

Study objective: to evaluate the clinical effect of adding octenidine dihydrochloride solution to the local oral hygiene care protocol in patients receiving respiratory support.

Materials and Methods

A single-center prospective cohort study with propensity score matching (PSM) for the control group was conducted in the therapeutic intensive care unit (ICU) of the I.I. Mechnikov North-Western State Medical University (NWSMU) from October 5, 2023, to May 20, 2026. Approval was obtained from the local ethics committee of NWSMU (Protocol No. 2, dated February 12, 2020). Upon admission to the hospital, all patients signed informed consent for medical intervention and processing of personal data. All study participants

signed informed consent, disclosing that they may receive the investigational drug.

The inclusion criteria for the study were as follows: age 18 to 95 years inclusive; presence of hypoxemia ($\text{SpO}_2 < 90\%$ or $\text{PaO}_2 < 60$ mm Hg) while on low-flow oxygen therapy, requiring escalation to respiratory support (high-flow oxygen therapy, noninvasive ventilation, or invasive ventilation); presence of dental plaque ($\text{PI} \geq 1.0$) and gingival inflammation ($\text{MGI} \geq 1.0$); and periodontal pocket depth < 5 mm.

The exclusion criteria were as follows: refusal to participate in the study; impaired consciousness that prevented the patient from signing the informed consent form; the presence of a hospital-acquired infection at the time of study enrollment (lower respiratory tract infection, catheter-associated urinary tract infection, catheter-associated bloodstream infection); a history of allergic reactions to octenidine dihydrochloride; the presence of severe periodontitis (periodontal pockets > 6 mm) or acute ulceronecrotic gingival lesions; and the presence of severe xerostomic syndrome ($\text{CSCOD} > 7$ scores) at screening.

The study primary endpoint was change from baseline in the modified gingival index (MGI). Secondary endpoints included changes in the plaque index (PI) and in the xerostomia score assessed by CSCOD, as well as the incidence of lower respiratory tract infection (LRTI).

The sample size was planned based on the primary endpoint (change in MGI between days 1 and 3 of follow-up). According to the pilot analysis, the expected between-group difference in ΔMGI_{1-3} was approximately 0.3 scores, with a standard deviation of about 0.4 scores. With a two-sided significance level of $\alpha = 0.05$, 80% power, and a 1:1 group allocation ratio, the minimum required sample size was 29 patients per group. Taking into account the nonrandomized study design, the need for subsequent PSM, and possible missing data, an expanded initial sample was assembled. The final dataset included 299 patients, 63 of whom had an adverse outcome (death).

The following baseline covariates, recorded on day 1, were included in the PSM model: age, scores on the ICOCFAS, MGI, PI, and CSCOD scales, the Charlson Comorbidity Index (CCI), and the presence of orthodontic appliances (prostheses). The patient flow and covariate balance are shown in the Appendix (Tables 1 and 2).

The probability of group assignment was estimated using logistic regression. Patients were matched using nearest-neighbor matching at a 1:1 ratio without replacement of control-group patients. To limit the allowable distance between matched patients, a caliper equal to 0.30 of the standard deviation of the logit of the estimated probability was used. The actual caliper value was 0.155. Matching quality was assessed using standardized mean differences (SMDs).

An SMD of <0.10 was considered optimal balance. The SOFA (Sequential Organ Failure Assessment) score was not included in the main matching model because of the large number of missing values; after matching, balance for SOFA was additionally assessed among patients with available data (SMD 0.008). To compare changes in the overall matched sample, the Wilcoxon signed-rank test for paired samples was used, since after PSM patients were paired. After matching, 104 patient pairs were enrolled in the intervention and control groups. In the intervention group ($n=104$), patients received standard care, including supervised tooth brushing with toothpaste twice daily for 2 minutes, and a mouth rinse with 15 mL of 0.1% octenidine dihydrochloride solution for 30 seconds. In the control group ($n=104$), patients received the same standard care and mouth rinse with 15 mL of distilled water for 30 seconds.

The study scheme is presented in Fig. 1.

The frequency of oral rinsing was determined using the ICOCFAS scale, which takes into account the condition of the oral mucosa, age, and the type of respiratory and nutritional support [16]. For all patients, oral hygiene procedures were performed using an oral care kit containing a foam swab, suction tube, toothbrush, and vacuum connector. The introduction of the local oral hygiene protocol into routine clinical practice was accompanied by quarterly training workshops held jointly with epidemiologists under the supervision of a dentist.

A dentist assessed the condition of the oral cavity and monitored the effectiveness of oral hygiene measures on days 1, 3, and 7 of intensive care using the following indices and scales: the plaque index (PI), the gingivitis index (MGI), and the clinical xerostomia assessment scale (CSCOD).

The severity of gingivitis was evaluated using the modified gingivitis index (MGI, Lobene, 1986). An abbreviated examination protocol was used, assessing the condition of the gingiva in the area of all present molars, incisors, and canines in the upper and lower jaws (excluding premolars). The index was calculated as the arithmetic mean of the scores obtained for each patient.

Analyzed parameters: age (years), gender, primary and concomitant diseases, CCI (scores), duration of respiratory support (days), presence of dental prostheses (yes/no), ICU length of stay (days), ICOCFAS (score), MGI (score), PI (score), and CSCOD (score) (Appendix, Table 3).

The data were statistically processed using Jamovi 2.6.26, as well as the Python programming language for additional analysis and visualization.

Quantitative variables were presented as the median (Me) and interquartile range (Q_1-Q_3). Categorical variables were described using absolute frequencies and percentages — n (%). Quantitative measures in two independent groups were compared using the nonparametric Mann–Whitney U test. Pearson's chi-square test was used to analyze contingency tables; when the expected frequency in any cell was less than 5, Fisher's exact test was applied. To assess whether the magnitude of the intervention effect depended on the clinical outcome, an interaction analysis of «group $\times$ outcome» was performed (reference category: unfavorable outcome). The coefficient for the «group» variable reflects the difference in the change in MGI between the intervention and control groups in patients with an unfavorable outcome, whereas the interaction coefficient indicates whether this effect changes in patients with a favorable outcome.

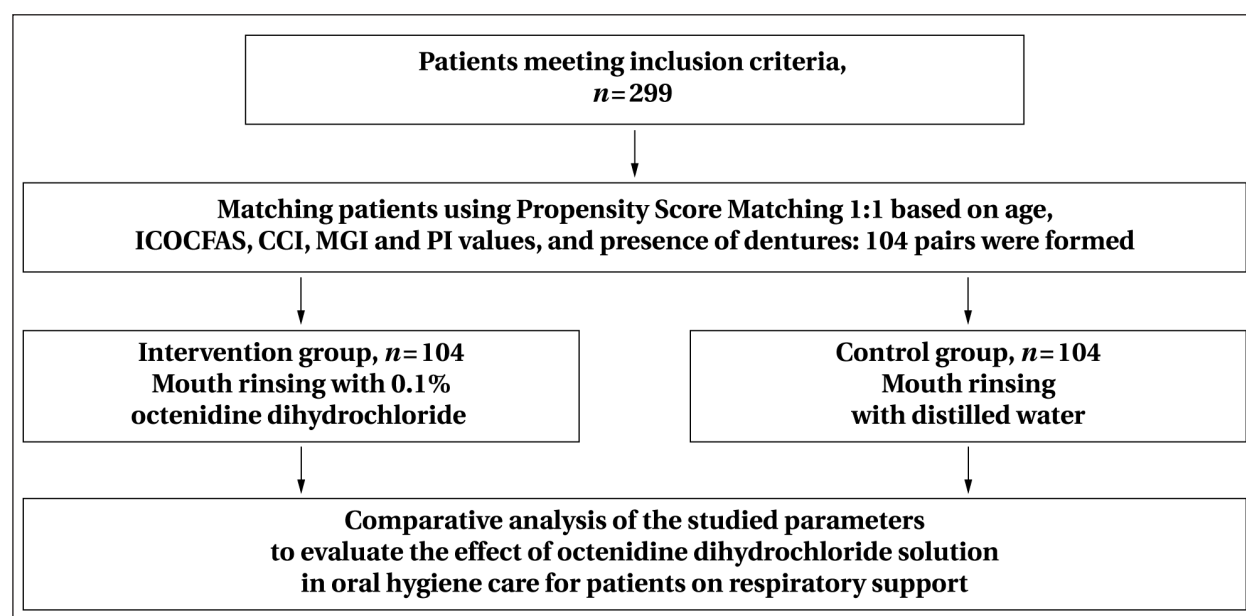


Fig. 1. Study scheme.

Table 1. General characteristics of the groups after PSM.

Parameters	Parameter values in the groups		<i>p</i>
	Intervention, <i>n</i> = 104	Control, <i>n</i> = 104	
Age, years, <i>Me</i> (Q1; Q3)	71 (60.75; 80)	72 (63.75; 80.25)	0.813
Gender, <i>f n</i> (%)	60 (57.7)	56 (53.8)	0.577
SOFA, score, <i>Me</i> (Q1; Q3)	8 (6; 10)	8 (6; 12)	0.969
CCI, score, <i>Me</i> (Q1; Q3)	7 (6; 8)	7 (5.75; 8)	0.788
ADHF, <i>n</i> (%)	89 (85.6)	85 (81.7)	0.453
DM, <i>n</i> (%)	38 (36.5)	42 (40.4)	0.569
ECLD, <i>n</i> (%)	20 (19.2)	20 (19.2)	1.0
SCAP, <i>n</i> (%)	30 (28.8)	27 (26)	0.641
GCS, <i>n</i> (%)	22 (21.2)	26 (25)	0.51
ABT, <i>n</i> (%)	78 (75)	76 (73.1)	0.752
Anemia, <i>n</i> (%)	58 (55.8)	60 (57.7)	0.78
Dentures, <i>n</i> (%)	53 (51)	55 (52.9)	0.781
ICOCFAS, балл, <i>Me</i> (Q1; Q3)	30 (26; 32)	30 (27.75; 32)	0.862
MGI, <i>Me</i> (Q1; Q3)	2.1 (1.8; 2.5)	2.1 (1.8; 2.42)	0.824
PI, <i>Me</i> (Q1; Q3)	2 (1.8; 2.12)	2 (1.68; 2.2)	0.888
CSCOD, <i>Me</i> (Q1; Q3)	6 (6; 7)	6 (6; 7)	0.998

Note. SOFA — the Sequential Organ Failure Assessment score; CCI — Charlson Comorbidity Index; ADHF — acute decompensated heart failure; ECLD — exacerbation of chronic lung disease; SCAP — severe community-acquired pneumonia; DM — decompensated diabetes mellitus; GCS — glucocorticosteroids; ABT — antibacterial therapy. For Tables 1 and 4: ICOCFAS — Intensive Care Oral Care Frequency Assessment Scale. For Tables 1, 2, 4, and 5: MGI — Modified Gingival Index, Lobene; PI — Plaque Index; CSCOD — The Challacombe Scale of Clinical Oral Dryness.

Table 2. Comparison of index changes across the study groups.

Parameters	Parameter values in the groups		<i>p</i> Δ_{1-3}	Parameter values in the groups		<i>p</i> Δ_{1-7}
	Intervention Δ_{1-3}	Control Δ_{1-3}		Intervention Δ_{1-7}	Control Δ_{1-7}	
MGI	-0.25 (-0.4; -0.2)	0 (-0.1; 0)	<0.001	-0.4 (-0.75; -0.3)	-0.1 (-0.1; 0.1)	<0.001
PI	-0.3 (-0.5; -0.1)	-0.1 (-0.1; 0)	<0.001	-0.5 (-0.8; -0.3)	-0.1 (-0.2; 0)	<0.001
CSCOD	0 (-1; 0)	0 (-1; 0)	0.094	-1 (-2; 0)	-0.5 (-1; 0)	0.119

Note. For Tables 2 and 3: Δ_{1-3} and Δ_{1-7} — indicate the change in the parameter between days in the ICU.

Pairwise correlations between the ICOCFAS scale and dental indices (MGI, PI, CSCOD) over time (on days 1, 3, and 7) were assessed using repeated-measures correlation (*rmcorr*). This approach made it possible to analyze within-subject associations over time while excluding the effect of between-subject variability. Results were presented as the repeated-measures correlation coefficient (*r_{rm}*) and the two-tailed significance level (*p*). The strength of the correlation was interpreted as follows: *r_{rm}* < 0.10 — essentially no association; 0.10–0.29 — weak; 0.30–0.49 — moderate; 0.50–0.69 — noticeable; 0.70–0.89 — high; ≥ 0.90 — very high. The direction of the association was determined by the sign of the coefficient. Differences and correlations were considered statistically significant at *p* < 0.05.

Results

After PSM, the intervention and control groups were well balanced in terms of baseline clinical and dental characteristics: all key standardized mean differences were < 0.10. In addition, between-group differences in the analyzed parameters did not reach statistical significance (Table 1).

An analysis of changes in the indicators over the interval from day 1 to day 3 (Δ_{1-3}) demonstrated statistically significant between-group differences (Table 2). In the intervention group, a more pronounced reduction in the MGI and PI indices was observed (by 0.25 scores and 0.3 scores, respectively)

compared with the control group (*p* < 0.001). No statistically significant between-group differences were found in CSCOD dynamics over the Δ_{1-3} interval. The median value in both groups remained at zero: 0 [0; 0] score in the intervention group and 0 [-1; 0] score in the control group (*p* = 0.094). By day 7 (Δ_{1-7}), the positive changes in the MGI and PI indices in the intervention group became more evident, and the differences between the compared groups remained highly significant (*p* < 0.001). Over the Δ_{1-7} interval, changes in the CSCOD scale were relatively modest: the decrease of 1 score was documented in the intervention group versus 0.5 scores in the control group; however, no statistically significant between-group differences were observed (*p* = 0.119).

Fig. 2 shows the dynamics of the MGI index in the compared groups.

To assess whether the intervention effect depended on clinical outcome, we conducted an interaction analysis of «group × outcome», with unfavorable outcome serving as the reference category. In this model, the coefficient for the «group» variable characterizes the difference in MGI dynamics between groups specifically among patients with an unfavorable outcome. The interaction coefficient, in turn, shows how much this effect is amplified or attenuated in the case of a favorable outcome.

For the ΔMGI_{1-3} measure, the group effect was statistically significant (β = -0.204; *p* = 0.005),

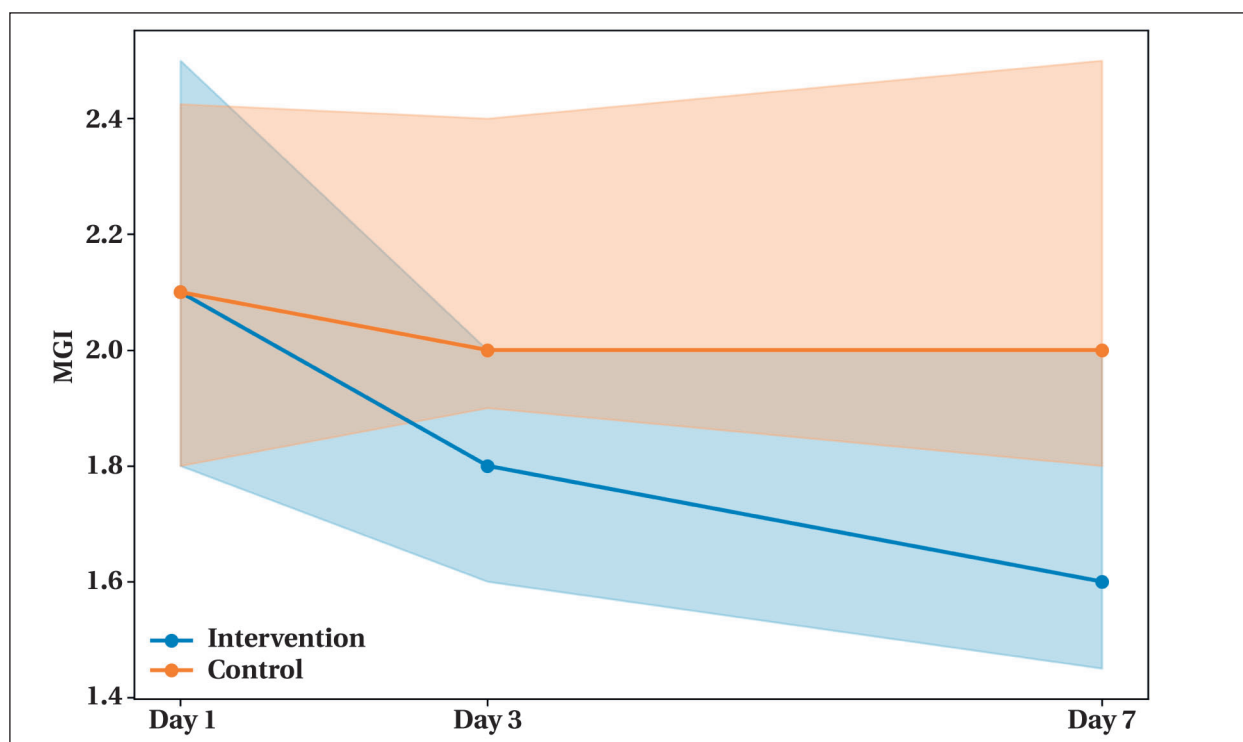


Fig. 2. Changes in the modified gingival index (MGI) in the study groups.

Table 3. Analysis of the interaction «group × vital outcome».

End point	<i>n</i>	β of the group	<i>p</i> of the group	β of interaction «group × favorable outcome»	<i>p</i> of interaction
ΔMGI_{1-3}	208	-0.204	0.005	-0.090	0.269
ΔMGI_{1-7}	97	-0.313	0.012	-0.221	0.141

Table 4. Assessment of correlation between indices and scales.

Relationship between metrics	<i>r_{rm}</i>	95% CI	<i>p</i>	<i>df</i>	Observations, <i>n</i>	Patients, <i>n</i>	Interpretation
ICOCFAS ~ MGI	0.613	0.537–0.678	< 0.001	304	513	208	Noticeable
ICOCFAS ~ PI	0.593	0.514–0.661	< 0.001	304	513	208	Noticeable
ICOCFAS ~ CSCOD	0.548	0.464–0.622	< 0.001	303	511	207	Noticeable
MGI ~ PI	0.806	0.763–0.842	< 0.001	304	513	208	High
MGI ~ CSCOD	0.530	0.444–0.606	< 0.001	303	511	207	Noticeable
PI ~ CSCOD	0.515	0.427–0.593	< 0.001	303	511	207	Noticeable

Note. *r_{rm}* — is the repeated-measures correlation coefficient; *df* — is the number of degrees of freedom.

which by day 3 was reflected in a more substantial reduction in the MGI index in the intervention group compared with the control group (Fig. 2). For the ΔMGI_{1-7} measure, the group effect also persisted ($\beta = -0.313$; $p = 0.012$). No statistically significant «group × clinical outcome» interaction was identified, indicating that the intervention effect did not depend on the clinical outcome (Table 3).

All pairwise correlations between the MGI and PI indices and the ICOCFAS and CSCOD scales were statistically significant ($p < 0.001$). The strongest association was found between MGI and PI ($r_{rm} = 0.806$), while the remaining correlations were noticeable (r_{rm} ranging from 0.515 to 0.613) (Table 4).

No statistically significant inter-group differences were found for any of the analyzed complications or outcomes (Table 5). Severe xerostomia

syndrome (CSCOD ≥ 6 points) as a complication was recorded in 35% of patients. The incidence of LRTI was 1.9% in the intervention group and 5.8% in the control group ($p = 0.279$).

All patients in the intervention group showed good tolerability of the 0.1% octenidine dihydrochloride solution; no allergic reactions or mucosal irritation were reported with the use of the mouthwash. No adverse events, such as burning, itching, or altered taste, were also observed.

Discussion

The patient group under study lends particular importance to this issue: in elderly patients, age-related changes, comorbidity, and polypharmacy create a unique background for dental complications. The median age in the study groups was 72 (62; 80) years, and the median Charlson Comorbidity Index

Table 5. Complications and clinical outcomes in patients with plaque-induced gingivitis.

Parameters	Parameter values in the group		<i>p</i>
	Intervention, <i>n</i> = 104	Control, <i>n</i> = 104	
Complications			
Oral candidosis, <i>n</i> (%)	13 (12.5)	16 (15.4)	0.548
Severe xerostomia syndrome (CSCOD I 6), <i>n</i> (%)	36 (34.6)	34 (32.7)	0.769
LRTI, <i>n</i> (%)	2 (1.9)	6 (5.8)	0.279
Outcomes			
Days on RS, <i>Me</i> (Q1; Q3)	5 (3; 7)	3 (3; 6)	0.114
BD in ICU, <i>Me</i> (Q1; Q3)	6 (4; 8)	6 (4; 11)	0.13
Lethal outcome, <i>n</i> (%)	24 (23.1)	22 (21.2)	0.738

Note. LRTI — lower respiratory tract infection; RS — respiratory support; BD — bed-day.

was 7 (6; 8) scores. Acute decompensation of chronic heart failure (ADCHF), which required the prescription of xerogenic medications (angiotensin-converting enzyme inhibitors/ARBs, diuretics, etc.), was identified in 174 (83.6%) patients; diabetes mellitus was present in 80 (38.4%). In this patient cohort, the use of xerogenic medications and glucocorticosteroids, poor oral hygiene, and the presence of prosthetic appliances all contribute to microbial colonization [21, 22].

According to a recent study conducted in Flanders, poor level of hygiene for removable dentures was documented in 68.5% of older adults living in nursing homes, with xerostomia being the leading complaint (32.8%) [23]. In the present study, prosthodontic dental appliances were present in 108 patients (51.9%), of whom 23 (21.2%) used removable appliances.

Xerostomia and immunosuppression further increase susceptibility to bacterial and fungal infections [21]. Microtrauma to the mucosal lining, triggered by changes in ventilation settings and alterations in the flow of the respiratory gas mixture, facilitates bacterial adhesion [24]. As a result, oral hygiene is difficult to maintain in critically ill elderly patients, which is accompanied by reduced microbial alpha diversity and an increase in pathogenic bacteria [25].

In a study by A. Gómez et al., among ICU patients, gingivitis was found in 54.5% of cases, ulcerative lesions in 45.4%, and xerostomia, caries, and periodontitis were observed in equal proportions (36.4%) [7]. In another study conducted among residents of nursing homes older than 80 years, the mean MGI score was 1.8 ± 1.2 , with the score reaching 2.1 in 41% of cases [23].

Teeth brushing and the use of mouth rinses are basic hygiene procedures for patients receiving respiratory support [26]. In a study by Yao et al., twice-daily tooth brushing helped reduce the PI score [27], while in a study by Marino et al., a similar procedure was associated with lower GI and PI values [28]. At the same time, tooth brushing leads to a significant increase in the number of bacteria in saliva, so rinsing the oral cavity afterwards is mandatory [29].

The choice of a 0.1% octenidine dihydrochloride solution as a rinse was driven by its broad biocidal

activity, high clinical efficacy [11, 12], and favorable safety profile [30, 31]. The presence of multiple comorbidities in patients receiving respiratory support places stringent safety requirements on antiseptics. All patients reported good tolerance of the 0.1% octenidine dihydrochloride solution; no allergic reactions or signs of mucosal irritation (itching, burning, swelling) were observed, which is consistent with data from earlier studies [30, 31].

The frequency of oral mucosa irrigation was calculated according to the ICOCFAS scale [16]. The correlation analysis performed showed (Table 4) that the severity of the overall condition and the frequency of irrigations according to the ICOCFAS scale significantly correlated with the severity of gingivitis (MGI: $r_{rm}=0.613$), dental plaque (PI: $r_{rm}=0.593$), and xerostomia (CSCOD: $r_{rm}=0.548$). As expected, the strongest association was found between dental plaque and gingival inflammation ($r_{rm}=0.806$), which confirms the pathogenetic role of biofilm in the development of gingivitis, supports the use of octenidine, due to its strong anti-plaque effect, and is consistent with studies demonstrating its advantages over other antiseptics in reducing dental plaque and gingival inflammation [11, 30, 31]. In the present study, we showed that a 0.1% octenidine dihydrochloride solution provides a statistically significant reduction in the MGI and PI scores as early as on day 3 (Table 2), with a further increase in effect by day 7 ($p < 0.001$). At the same time, the effect of octenidine (Table 3) on MGI did not depend on the clinical outcome ($p=0.269$ for ΔMGI_{1-3} and $p=0.141$ for ΔMGI_{1-7}).

The reduction in the MGI and PI scores in the intervention group compared with the control group (Fig. 2) confirmed the advantage of the local protocol using a 0.1% octenidine dihydrochloride solution for eliminating hospital-acquired biofilm. These changes are critically important for preventing nosocomial infections, including lower respiratory tract infections, in patients on ventilatory support, because a compromised epithelial barrier serves as a potential portal of entry for microorganisms [32].

On day 7, plaque-induced gingivitis (MGI > 2.1 scores) was identified in 40% of patients receiving

respiratory support (40.4% in the intervention group versus 41.3% in the control group; $p=0.88$). This finding does not contradict the statistically significant reduction in ΔMGI_{1-7} observed in the intervention group described above, since it reflects not the dynamics of the process but the absolute prevalence of residual inflammatory signs.

At the same time, no statistically significant differences in the incidence of LRTI were found between the groups (Table 5): 1.9% in the intervention group vs. 5.8% in the control group ($p=0.279$). The observed threefold trend toward a reduction in LRTI underscores the need for further multicenter studies with sample size calculations based on infectious outcomes.

The development of severe xerostomia syndrome in patients receiving respiratory support is due to a combination of factors: the use of pressurized oxygen-air mixtures, administration of xerogenic medications, and reduced salivary secretion in the setting of endotoxemia. Analysis of the data obtained showed that irrigation of the oral mucosa with a 0.1% octenidine dihydrochloride solution had no significant effect on the severity of xerostomia syndrome. Xerostomia (CSCOD) showed a weaker correlation with the MGI and PI values ($r_{rm}=0.515-0.548$), indicating the stochastic nature of its association with the local inflammatory process (Table 4). The median CSCOD score during the first three days remained zero (Table 2) in both groups ($p=0.094$), and by day 7 the reduction was minimal (1 score in the intervention group vs. 0.5 scores in the control group; $p=0.119$). The persistence of xerostomia despite treatment in patients receiving respiratory support confirms the hypothesis that systemic (organ-related or pharmacological) factors play the dominant role in hyposalivation. A promising approach to correcting xerostomia may be the use of mucoadhesive moisturizing gels and/or moisturizing toothpaste that resist being washed away by saliva and provide prolonged protection of the epithelium [33].

Supplement

Table 1. Patient flow.

Stage	Total	Main group	Control group
Initial analytical base	299	152	147
Covariates available. PSM	276	137	139
After PSM 1:1	208	104	104
Available ΔMGI_{1-3}	208	104	104
Available ΔMGI_{1-7}	97	47	50

Table 2. Covariate Balance.

Variable	SMD before PSM	SMD after PSM
ICOCFAS day 1	0,168	0,035
Age	0,093	0,024
CCI	0,025	0,006
MGI day 1	0,046	0,029
PI day 1	0,047	0,003
SOFA	0,069	0,008
Dentures	0,367	0,038
CSCOD day 1	0,253	0,049

Study limitations. This study has several methodological limitations. First, the single-center design limits external validity, although it did help ensure consistency of protocols. Second, no comparative analysis by type of respiratory support was performed because NIPPV and HFOT were used in combination, and the subgroups receiving monotherapy were not sufficiently representative; any attempt at stratification would have created an unacceptable risk of false-negative results. Third, the limited sample size did not allow for a detailed assessment of infectious complications, and the short follow-up period (7 days) may not have captured long-term outcomes. Finally, despite the use of PSM, the prospective cohort design does not fully exclude residual confounding. Nevertheless, we believe that the internal validity of the study remains high, and the limitations listed above should be viewed as an impetus for larger multicenter studies.

Conclusion

The identified strong correlation between changes in the dental plaque index and gingival inflammation ($r_{rm}=0.806$) confirms that, in elderly ICU patients, the main etiopathogenetic factor in gingivitis is the microbial biofilm. This provides a pathophysiological rationale for the routine clinical use of antiseptics with targeted anti-plaque activity.

The use of a 0.1% octenidine dihydrochloride solution as part of an oral hygiene protocol in patients receiving respiratory support provides rapid reduction of gingival inflammation (decrease in MGI score) and effective removal of dental plaque (decrease in PI score) as early as day 3, with a greater effect by day 7.

The severity of xerostomia in patients receiving respiratory support persists regardless of the oral hygiene protocol, which calls for additional methods to manage it, including the use of mucoadhesive moisturizing gels and moisturizing toothpaste.

Table 3. Indices and Scales.

№	Index/sale	References
1	Modified Gingival Index — MGI	Lobene R. R., Weatherford T., Ross N. M., Lamm R. A., Menaker L. A modified gingival index for use in clinical trials // <i>Clinical Preventive Dentistry</i> . 1986. Vol. 8, No. 1. P. 3–6.
2	Plaque Index — PI, Silness-Loe, 1964	Löe H. The Gingival Index, the Plaque Index and the Retention Index Systems. <i>J Periodontol</i> . 1967; 38 (6): Suppl: 610-6. doi: 10.1902/jop.1967.38.6.610. PMID: 5237684.
3	Xerostomia severity scale — Challacombe Scale of Clinical Oral Dryness — CSCOD, Challacombe S.J. et al., 2008	Osailan S.M., Pramanik R., Shirlaw P., Proctor G.B., Challacombe S.J. Clinical assessment of oral dryness: development of a scoring system related to salivary flow and mucosal wetness. <i>Oral Surg Oral Med Oral Pathol Oral Radiol</i> . 2012; 114: 597–603.
4	Intensive Care Oral Care Frequency Assessment Scale, ICOCFAS, 2022	Doğu Kökcü Ö., Terzi B. Development of an intensive care oral care frequency assessment scale. <i>Nursing in critical care</i> . 2022; 27 (5): 667–675. DOI: 10.1111/nicc.12529. PMID: 32633044.

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Received 06.05.2026

Accepted 08.07.2026