

# Comparison of chlorhexidine 0.12% and fluoride toothpaste as oral hygiene agents on oral microorganisms and Beck oral assessment scale in mechanically ventilated patients

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## Abstract

**Objective:** The primary goal of this study was to conduct a comprehensive analysis of the comparative effects of chlorhexidine 0.12% and fluoride toothpaste as oral hygiene agents in mechanically ventilated patients, with a specific focus on their impact on oral microorganisms and hygiene.

**Methods:** This single-blinded, randomized clinical trial was conducted at Dr. Wahidin Sudirohusodo General Hospital in Makassar, Indonesia, from April to August 2024. The study population consisted of all patients on mechanical ventilation in the hospital's intensive care unit (ICU) during this period. Participants were randomly assigned into two groups: one received oral care with chlorhexidine 0.12% and the other with fluoride toothpaste. This division allowed for a direct comparison of the effects of each oral hygiene agent on reducing oral microorganism colonies and improving Beck oral assessment scale (BOAS) scores among mechanically ventilated ICU patients.

**Results:** A total of 20 patients participated in this study, evenly divided between the two intervention groups: chlorhexidine 0.12% and fluoride toothpaste. The comparison of oral microorganism colonies before and after the intervention revealed a significant reduction in both groups ( $p < 0.05$ ). However, there was a notably more significant reduction in the chlorhexidine 0.12% group, indicating its superior effectiveness in lowering oral microorganism colonies. This finding has practical implications for oral care in ICU settings, suggesting that chlorhexidine 0.12% may be a more effective choice. Similarly, BOAS scores also showed a more significant decrease in the chlorhexidine group, further supporting its effectiveness as an oral hygiene agent in mechanically ventilated patients.

**Conclusion:** Chlorhexidine 0.12% has proven more effective than fluoride toothpaste as an oral hygiene agent, particularly in mechanically ventilated patients.

**Key words:** Mechanical ventilation, chlorhexidine, fluoride, oral hygiene.

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## Introduction

Mechanical ventilation is a primary method for sustaining organ function in patients undergoing treatment in the intensive care unit (ICU). (1) However, ventilator-associated pneumonia (VAP) is a common complication among patients receiving mechanical ventilation. (2) The etiology of VAP is linked to insufficient oral hygiene in these patients. ICU patients are susceptible to the rapid onset of oral complications due to factors like malnutrition, the presence of tracheal and nasogastric tubes, and reduced saliva production, all of which contribute to the rapid accumulation of dental plaque. (3) Within 48 hours of ICU admission, the oral microbiome

shifts significantly, favoring the growth of gram-negative organisms contributing to plaque formation. Aspiration of these pathogens can subsequently introduce them into the lungs, potentially leading to VAP. (4)

Adherence to oral hygiene protocols may reduce the incidence of VAP. (5) Chlorhexidine, a well-known broad-spectrum antibacterial agent, is frequently used in mouthwash to curb oral germ colonization and inhibit microorganism migration to the lungs. (6) However, the biofilm that forms on teeth can reduce the efficacy of mouthwash, necessitating mechanical removal of plaque, which has shown significant effectiveness in ICU settings. (7)

Studies indicate that tooth brushing is a beneficial approach to reduce dental plaque and lower the risk of VAP. Additionally, fluoride toothpaste enhances enamel resistance to decay and has demonstrated superior antibacterial effects compared to herbal toothpaste and chlorhexidine, particularly against *Streptococcus mutans*. This study aimed to examine the comparative effectiveness of chlorhexidine 0.12% and fluoride toothpaste as oral hygiene agents in patients receiving mechanical ventilation, with a focus on their ability to reduce oral bacterial colonization and prevent VAP. (3,8-10)

## Methods

This single-blinded, randomized clinical trial was conducted at Dr. Wahidin Sudirohusodo General Hospital, Makassar, Indonesia, between April and August 2024, involving ICU patients on mechanical ventilation. Ethical approval was granted by the Faculty of Medicine, Hasanuddin University, and informed consent was obtained from all participants. Patients aged 18-65 who were normal or overweight and met the inclusion criteria were enrolled. Exclusion criteria included severe facial/oral injury, denture use, chlorhexidine intolerance, and pre-existing pneumonia. A consecutive sampling method was used to recruit participants.

Patients were randomly divided into two groups: one receiving chlorhexidine 0.12% and the other fluoride toothpaste for oral care. Baseline assessments included the Beck oral assessment scale (BOAS) and saliva samples to quantify microbial colonies in colony-forming units per milliliter (CFU/ml). Each oral hygiene session with the patient in a 30° head-up position involved swabbing and brushing for 5 minutes, followed by suction, twice daily over five days.

Post-intervention BOAS scores and microbial colony counts were reassessed on the fifth day. Oral microbial colony analysis was conducted according

to standard procedures at the hospital's clinical microbiology lab. This study was specifically designed to compare the efficacy of chlorhexidine and fluoride toothpaste in reducing oral microorganism levels and improving oral health in mechanically ventilated patients, a comparison that could significantly influence patient care practices.

## Results

This study included 20 patients, divided equally into two groups: chlorhexidine 0.12% and fluoride toothpaste. Baseline characteristics were homogeneous across groups ( $p>0.05$ ), with no significant differences (**Table 1**).

Before the intervention, oral microorganism colony counts were similar between groups (**Table 2**). After five days, both groups showed significant reductions in microorganism colonies ( $p<0.05$ ), with the chlorhexidine group experiencing a more significant decrease than the fluoride group (**Tables 2 and 3, Figure 1**).

BOAS scores, initially comparable, also decreased significantly in both groups post-intervention ( $p<0.05$ ). However, the chlorhexidine group showed a more significant improvement in BOAS scores than the fluoride group (**Tables 4 and 5, Figure 2**).

In summary, both interventions reduced oral microorganisms and improved BOAS scores, with chlorhexidine yielding more significant reductions in both measures.

## Discussion

This study demonstrated that chlorhexidine 0.12% significantly reduced oral microorganism colonies in mechanically ventilated patients. This finding aligned with research indicating that microbial counts in intubated patients decreased 12 hours after oral hygiene using chlorhexidine 0.12%. (11) Similarly, another study reported a significant reduction in oropharyngeal colonization in patients administered chlorhexidine 0.12% compared to a placebo group by day 3. Using chlorhexidine 0.12% for oral hygiene has proven effective in preventing VAP and reducing microbial colonization in mechanically ventilated patients. Another study reported that patients receiving chlorhexidine 0.12% for 7 days showed a 100% higher clearance rate of *Staphylococcus*, *Escherichia coli*, and *Pseudomonas aeruginosa* than the control group. (12,13)

The use of chlorhexidine 0.12% in this study effectively lowered the BOAS scores in mechanically ventilated patients, indicating improved oral hygiene. This result aligned with prior research showing that ICU patients receiving

chlorhexidine 0.12% oral care had significantly lower mean BOAS scores than a control group. (14) A lower BOAS score reflected enhanced oral hygiene. (15)

Chlorhexidine's antibacterial action is attributed to its positive charge, which attracts the negatively charged bacterial cell wall. It binds selectively and strongly to phosphate-containing compounds on the bacterial surface. This binding allows chlorhexidine to penetrate the bacterial cell wall, disrupting its structural integrity. The process releases low molecular weight cytoplasmic components, such as potassium ions, and inhibits enzyme activity associated with the cytoplasmic membrane, effectively compromising bacterial function. (16)

This study's results suggested that routine fluoride toothpaste use effectively reduced dental plaque, which could serve as a reservoir for microorganisms. The observed reduction in oral microorganism colonies with fluoride toothpaste might be due to fluoride ions strengthening tooth structure, thus protecting against acid degradation and lowering bacterial growth by inhibiting bacterial enzymes and slowing their metabolism. (17) The significant decrease in BOAS scores in this study is likely attributed to fluoride's role in preventing caries, reducing plaque buildup, decreasing demineralization, and enhancing enamel remineralization. (18)

Using chlorhexidine 0.12% resulted in a more significant reduction in oral microorganism colonies and BOAS scores compared to fluoride toothpaste in mechanically ventilated patients. This finding is consistent with previous research, which reported that chlorhexidine exhibited a more significant inhibition zone diameter than fluoride toothpaste, indicating superior antibacterial efficacy. (10) Another study also found that chlorhexidine was more effective than toothpaste in maintaining healthy saliva levels, further supporting its benefits for oral health in ICU settings. (19)

Oral hygiene methods focus on two approaches: dental plaque removal and reduction of oral microorganisms. Both chlorhexidine and fluoride tooth-

paste reduce dental plaque and oral microorganisms. (10) Fluoride protects teeth against acid degradation and promotes easier remineralization, which helps prevent plaque formation. (20) However, chlorhexidine is more effective in preventing plaque formation than fluoride toothpaste, potentially due to its liquid form, which may reduce saliva concentration and lower the likelihood of plaque accumulation. (19)

Oral microorganism colonies showed a more significant reduction with chlorhexidine 0.12% compared to fluoride toothpaste. This reduction is attributed to chlorhexidine's bactericidal effect, whereas fluoride toothpaste primarily inhibits microbial metabolism and growth. The bactericidal effect of fluoride in toothpaste remains unclear. The enhanced reduction of oral microorganisms in the chlorhexidine group corresponded with improved oral hygiene effectiveness, as evidenced by a more significant decrease in BOAS scores compared to the fluoride group.

It's important to note that while this study provided valuable insights, it had some limitations. For example, it did not identify or compare specific types of oral microorganisms in each group, which could have provided a more detailed understanding of the effects of chlorhexidine and fluoride toothpaste. Additionally, the potential combined effect of chlorhexidine and fluoride toothpaste as an oral hygiene protocol was not explored, which could be a promising area for future research.

### **Conclusion**

Chlorhexidine 0.12% is more effective than fluoride toothpaste as an oral hygiene agent in reducing oral microorganism colonies and BOAS scores in mechanically ventilated ICU patients. This finding supports the recommendation of chlorhexidine 0.12% as a preferred oral hygiene agent for these patients. Future research should aim to identify and compare specific types of oral microorganisms affected by different oral hygiene agents to deepen understanding and optimize care protocols in ICU settings.

**Table 1.** Subject characteristics

Characteristics	Chlorhexidine 0.12% (n=10)	Fluoride toothpaste (n=10)	p-value
Age (years) <sup>a</sup>	37.10±16.61	35.70±14.98	0.845 <sup>ns</sup>
Body mass index (kg/m <sup>2</sup> ) <sup>b</sup>	22.15 (20.80-29.30)	22.55 (18.40-29.10)	0.436 <sup>ns</sup>

Legend: <sup>a</sup>Data in mean±SD, independent T-test; <sup>b</sup>Data in median (min-max), Mann-Whitney test; <sup>ns</sup>Non-significant (homogeneous data).

**Table 2.** Comparison of oral microorganism colonies based on measurement time and intervention group

Measurement time	Colonies of oral microorganisms (CFU/ml)		p-value <sup>a</sup>
	Chlorhexidine 0.12%, median (min-max)	Fluoride toothpaste, median (min-max)	
Before intervention	2.05x10 <sup>8</sup> (1.60x10 <sup>7</sup> -1.80x10 <sup>9</sup> )	8.40x10 <sup>7</sup> (7.70x10 <sup>6</sup> -9.20x10 <sup>8</sup> )	0.247 <sup>ns</sup>
After intervention	1.70x10 <sup>7</sup> (2.70x10 <sup>4</sup> -3.10x10 <sup>8</sup> )	1.70x10 <sup>7</sup> (1.70x10 <sup>6</sup> -2.80x10 <sup>8</sup> )	0.529 <sup>ns</sup>
p-value <sup>b</sup>	0.005*	0.005*	

Legend: CFU=colony-forming units.

<sup>a</sup>Mann-Whitney U test; <sup>b</sup>Wilcoxon test; <sup>ns</sup>Non-significant; \*Significant at p<0.05.

**Table 3.** Comparison of the decrease in oral microorganism colonies between groups

	Chlorhexidine 0.12%, median (min-max)	Fluoride toothpaste, median (min-max)	p-value
Decrease in oral microorganism colonies (%)	91.67 (10.23-99.99)	63.89 (2.60-93.93)	0.023*

Legend: Mann-Whitney U test; \*Significant at p<0.05.

**Table 4.** Comparison of BOAS scores based on measurement time and intervention group

Measurement time	BOAS score		p-value <sup>a</sup>
	Chlorhexidine 0.12%, mean±SD	Fluoride toothpaste, mean±SD	
Before intervention	14.60±2.07	12.60±2.22	0.052 <sup>ns</sup>
After intervention	8.80±1.69	8.30±1.49	0.492 <sup>ns</sup>
p-value <sup>b</sup>	<0.001*	<0.001*	

Legend: BOAS=Beck oral assessment scale; SD=standard deviation.

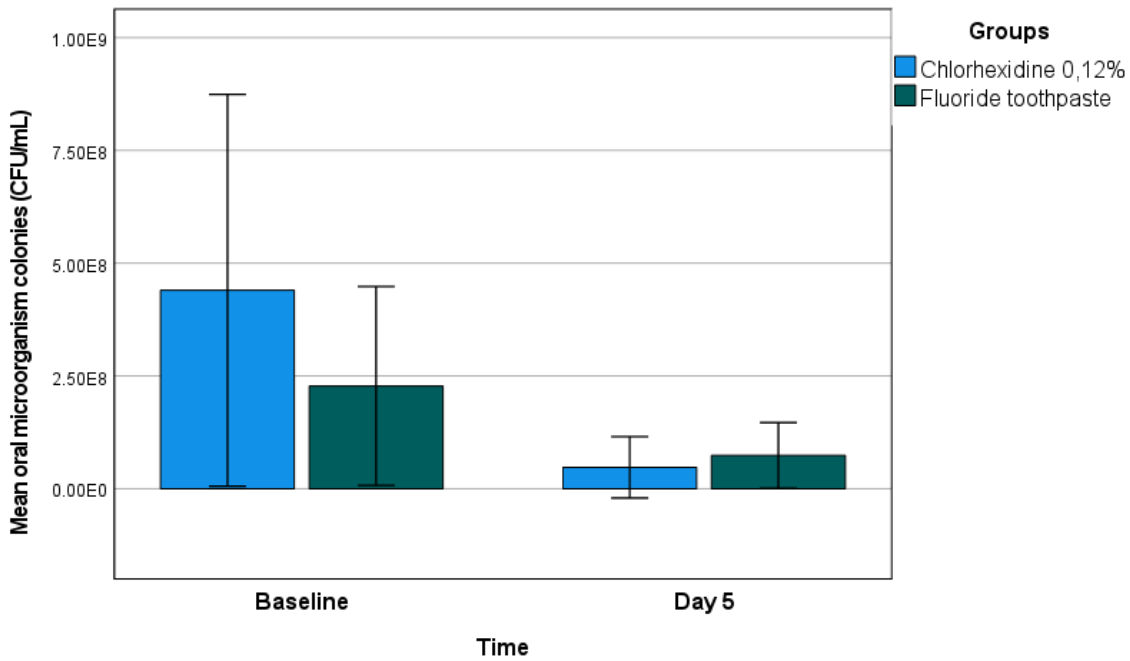
<sup>a</sup>Mann-Whitney U test; <sup>b</sup>Wilcoxon test; <sup>ns</sup>Non-significant; \*Significant at p<0.05.

**Table 5.** Comparison of the decrease in BOAS score between groups

	Chlorhexidine 0.12%, mean±SD	Fluoride toothpaste, mean±SD	p-value
Decrease in BOAS score	5.80±1.75	4.30±1.34	0.045*

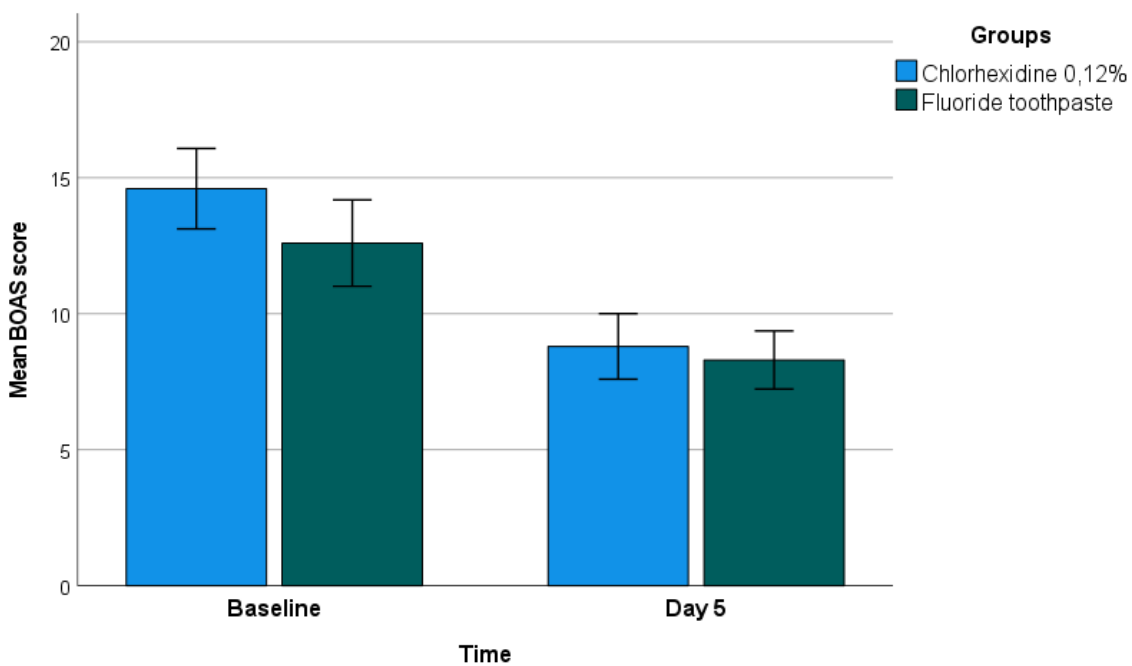
Legend: Mann-Whitney U test; \*Significant at p<0.05.

**Figure 1.** Comparison of oral microorganism colonies in both groups



Legend: CFU=colony-forming units.

**Figure 2.** Comparison of BOAS score in both groups



Legend: BOAS=Beck oral assessment scale.

## References

1. Alemayehu M, Azazh A, Hussien H, Baru A. Characteristics and outcomes of mechanically ventilated patients at adult ICU of selected public hospitals in Addis Ababa, Ethiopia. *Open Access Emerg Med* 2022;14:395-404.
2. Osman S, Al Talhi YM, AlDabbagh M, Baksh M, Osman M, Azzam M. The incidence of ventilator-associated pneumonia (VAP) in a tertiary care center: comparison between pre- and post-VAP prevention bundle. *J Infect Public Health* 2020;13:552-7.
3. Atashi V, Yousefi H, Mahjobipoor H, Bekhradi R, Yazdannik A. Effect of oral care program on prevention of ventilator-associated pneumonia in intensive care unit patients: a randomized controlled trial. *Iran J Nurs Midwifery Res* 2018;23:486-90.
4. Roberts N, Moule P. Chlorhexidine and toothbrushing as prevention strategies in reducing ventilator-associated pneumonia rates. *Nurs Crit Care* 2011;16:295-302.
5. Karimi S, Kolyaei E, Karimi P, Rahmani K. Effectiveness of supervised implementation of an oral health care protocol on ventilator-associated pneumonia patients in intensive care units: a double-blind multicenter randomized controlled trial. *Infect Prev Pract* 2023;5:100295.
6. Dai W, Lin Y, Yang X, Huang P, Xia L, Ma J. Meta-analysis of the efficacy and safety of chlorhexidine for ventilator-associated pneumonia prevention in mechanically ventilated patients. *Evid Based Complement Alternat Med* 2022;2022:1-10.
7. Silva PUJ, Paranhos LR, Meneses-Santos D, Blumenberg C, Macedo DR, Cardoso SV. Combination of toothbrushing and chlorhexidine compared with exclusive use of chlorhexidine to reduce the risk of ventilator-associated pneumonia: a systematic review with meta-analysis. *Clinics (Sao Paulo)* 2021;76:1-9.
8. Gupta A, Gupta A, Singh TK, Saxsena A. Role of oral care to prevent VAP in mechanically ventilated Intensive Care Unit patients. *Saudi J Anaesth* 2016;10:95-7.
9. Prendergast V, Jakobsson U, Renvert S, Hallberg IR. Effects of a standard versus comprehensive oral care protocol among intubated neuroscience ICU patients: Results of a randomized controlled trial. *J Neurosci Nurs* 2012;44:134-46.
10. Dewanti RI, Ciptaningtyas VR, Halleyantoro R, Wibobo GW. Comparison of antibacterial effectiveness of herbal toothpaste and fluoride on the growth of *Streptococcus mutans*. *Diponegoro Medical Journal* 2022;11:253-6.
11. Soares EL, Aldrigue RHS, da Rocha Gaspar MD, Franco GCN, Pochapski MT, Campagnoli EB, et al. Effects of chlorhexidine on the salivary microorganisms of patients in intensive care units. *Revista de Enfermagem Referencia* 2021;5:1-8.
12. Kes D, Aydin Yildirim T, Kuru C, Pazarlioglu F, Ciftci T, Ozdemir M. Effect of 0.12% chlorhexidine use for oral care on ventilator-associated respiratory infections: a randomized controlled trial. *J Trauma Nurs* 2021;28:228-34.
13. Chen Y-C, Ku E-N, Tsai P-F, Ng C-M, Wang J-L, Lin C-W, et al. Effect of 0.12% Chlorhexidine Oral Rinse on Preventing Hospital-Acquired Pneumonia in Nonventilator Inpatients. *J Nurs Res* 2022;30:e248.
14. Dale CM, Rose L, Carbone S, Pinto R, Smith OM, Burry L, et al. Effect of oral chlorhexidine de-adoption and implementation of an oral care bundle on mortality for mechanically ventilated patients in the intensive care unit (CHORAL): a multi-center stepped wedge cluster-randomized controlled trial. *Intensive Care Med* 2021;47:1295-302.
15. Subramonian A, Horton J. Chlorhexidine Oral Care in Critically Ill Adults. *Can J Health Technol* 2021;1:1-38.
16. Deus PF, Ouanounou A. Chlorhexidine in dentistry: pharmacology, uses, and adverse effects. *Int Dent J* 2022;72:269-77.
17. Jairoun AA, Al-Hemyari SS, Shahwan M, Jairoun O, Zyoud SH. Analysis of fluoride concentration in toothpastes in the United Arab Emirates: closing the gap between local regulation and practice. *Cosmetics* 2021;8:1-12.
18. Vranić E, Lacević A, Mehmedagić A, Uzunović A. Formulation ingredients for toothpastes and mouthwashes. *Bosn J Basic Med Sci* 2004;4:51-8.
19. Estaji Z, Alinejad M, Rakhshani MH, Rad M. The Comparison of Chlorhexidine Solution and Swab With Toothbrush and Toothpaste Effect on Preventing Oral Lesions in Hospitalized Patients in Intensive Care Unit. *Glob J Health Sci* 2016;8:211-6.
20. Bowden GHW. Effects of Fluoride on the Microbial Ecology of Dental Plaque. *J Dent Res* 1990;69 Spec No:653-9.

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