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Miswak's Extract for Oral Care Reduces VAP Risk in Ventilated Patients: A Case Study

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ABSTRACT

Ventilator-Associated Pneumonia (VAP) is a common nosocomial infection among patients receiving mechanical ventilation and is associated with increased morbidity, mortality, and prolonged length of stay in the intensive care unit (ICU). Poor oral hygiene is a key contributor to oropharyngeal bacterial colonization, which may facilitate the development of VAP. Miswak (Salvadora persica L.) contains natural antibacterial compounds and has potential as an alternative oral care intervention in nursing practice. This study employed an Evidence-Based Practice case study approach involving a mechanically ventilated patient in the ICU. Oral care using miswak extract was implemented for three consecutive days according to the established nursing care plan. Oral health status was assessed using the Beck Oral Assessment Score (BOAS), while the risk of VAP was evaluated using the Clinical Pulmonary Infection Score (CPIS). Following the intervention, oral hygiene improved significantly, as indicated by a reduction in the BOAS score from 7 to 3. The risk of VAP also decreased, demonstrated by a decline in the CPIS score from 7 (high risk) to 3 (low risk), accompanied by reduced purulent secretions and stable clinical parameters. These findings suggest that oral care using miswak extract is effective in improving oral hygiene and reducing VAP risk and may be recommended as a safe, practical, and evidence-based preventive intervention in ICU nursing practice.

Keywords
Healthcare Infection
Intensive Care Unit
Miswak's Extract
Oral Care
Ventilator-associated Pneumonia

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Introduction

Healthcare-Associated Infections (HAIs) are infections acquired during the provision of medical care and represent a significant global healthcare challenge [1]. They can occur in various healthcare settings, including hospitals, long-term care facilities, and outpatient clinics, and are frequently associated with invasive procedures, prolonged hospitalization, medical device use, and immunosuppression [2]. A meta-analysis involving 47,666 participants reported 7,658 HAI cases, with an overall prevalence of 21.6% in Southeast Asia (95% CI: 15.5–29.1%; I^2 = 100%). Indonesia had the highest prevalence at 30.4%, while Singapore reported the lowest at 8.4%, highlighting the substantial regional burden of HAIs [3].

Common HAIs include central line–associated bloodstream infections, catheter-associated urinary tract infections, surgical site infections, ventilator-associated pneumonia (VAP), and Clostridioides difficile infections. These infections not only increase morbidity and mortality but also prolong hospital stays, promote antimicrobial resistance, and escalate healthcare costs. Odoom and Donkor [4] reported 4,288 HAI cases among 15,966 ICU patients, with pneumonia exhibiting the highest prevalence. Pneumonia in ventilated patients occurred in 54.0% (95% CI: 31.0–76.0%), while non-ventilator pneumonia was 51.0% (95% CI: 40.0–63.0%). Bloodstream infections, urinary tract infections, and surgical site infections were 34.0%, 26.0%, and 12.0%, respectively.

Among HAIs, VAP is one of the most prevalent and severe complications in ICU settings. It is defined as pneumonia occurring at least 48 hours after endotracheal intubation and mechanical ventilation [5]. Globally, VAP incidence ranges from 7 to 43 cases per 1,000 ventilator days, with mortality rates from 6.3% to 66.9% [6]. In the United States, clinical guidelines from the American Thoracic Society and Infectious Diseases Society of America estimate VAP-related mortality at approximately 13%. European multicenter studies report 30-day mortality at 29.9%, with late-onset VAP showing higher mortality and prolonged ICU stays compared to early-onset cases [7]. The COVID-19 pandemic further increased VAP incidence and ICU mortality, emphasizing the vulnerability of mechanically ventilated patients [8].

VAP is commonly caused by Gram-negative bacteria such as Klebsiella spp., Escherichia coli, and Pseudomonas aeruginosa, as well as Gram-positive bacteria, including Staphylococcus

aureus, particularly methicillin-resistant strains (MRSA) [9]. Patients with VAP experience longer ICU stays, higher mortality, and increased risk of complications including acute respiratory distress syndrome, sepsis, and multidrug-resistant infections. Consequently, preventive measures, including oral care, are essential for reducing VAP incidence and improving patient outcomes.

Oral care is recognized as an effective strategy for VAP prevention, reducing oropharyngeal colonization by pathogenic microorganisms. Various oral care methods involve toothbrushing or non-toothbrushing techniques with antiseptic solutions such as chlorhexidine, hydrogen peroxide, sodium bicarbonate, or iodine [10], [11], [12]. While chlorhexidine is widely used in ICUs, its efficacy in reducing VAP is variable, and concerns regarding cytotoxicity and tissue irritation have been reported [13].

Miswak (Salvadora persica) has emerged as a natural, safe, and cost-effective alternative. Studies demonstrate its antibacterial properties against key VAP pathogens, including Streptococcus pneumoniae, Klebsiella spp., Staphylococcus aureus, and Escherichia coli [14], [15], [16], [17]. Compared to chemical antiseptics, Miswak shows minimal side effects and high biocompatibility, making it suitable for clinical use. Surveys among ICU nurses indicate that oral care, including the use of Miswak extract, improves patient comfort, ease of implementation, and adherence to evidence-based protocols [18].

Despite the promising evidence, research on Miswak extract–based oral care for mechanically ventilated patients in Indonesian ICUs remains limited. Current studies have not fully evaluated its effectiveness in reducing VAP risk within local nursing practice. Addressing this gap is essential for supporting evidence-based interventions, enhancing patient safety, and reducing HAI-related morbidity and mortality [19], [20], [21].

Therefore, this study aims to examine the effectiveness of oral care using Miswak extract in reducing the risk of ventilator-associated pneumonia in a mechanically ventilated patient. The findings are expected to provide evidence supporting the integration of natural antiseptics into ICU oral care protocols, ultimately improving clinical outcomes and promoting best practices in critical care nursing.

Material and Methods

A case study design was used to evaluate the effectiveness of oral care with Miswak extract in reducing ventilator-associated pneumonia (VAP) risk in a mechanically ventilated ICU patient at a type B hospital in West Java, Indonesia. The participant was a single adult (>18 years) receiving invasive mechanical ventilation for at least 48 hours. Patients with severe oral lesions, immunodeficiency, or Miswak hypersensitivity were excluded.

The intervention was performed over three days. An initial oral assessment was conducted using the Beck Oral Assessment Scale (BOAS) to determine hygiene status and guide

care frequency. Oral care involved brushing teeth, tongue, gums, and palate with a soft-bristled toothbrush and non-fluoride Miswak toothpaste, followed by rinsing with 0.9% NaCl using suction to prevent aspiration. Endotracheal tube fixation was monitored and repositioned as needed, and lips were moisturized after care.

Effectiveness was evaluated daily using the Clinical Pulmonary Infection Score (CPIS). This approach combined evidence-based nursing practice with systematic clinical monitoring to assess the impact of Miswak extract on VAP prevention in mechanically ventilated patients. The study was conducted as an evidence-based nursing implementation within routine clinical care, without the introduction of any experimental interventions or additional risks beyond standard care practices. All nursing procedures were performed in strict accordance with institutional policies and established professional ethical standards.

Results and Discussions

The assessment findings indicate that patients (Mr. N) with pneumonia who require mechanical ventilation for more than 48 hours are at high risk of developing Ventilator-Associated Pneumonia (VAP). This is evidenced by an initial Clinical Pulmonary Infection Score (CPIS) of 6 (high risk), leukocytosis (20,250/µL), purulent tracheal secretions, and positive culture results for Acinetobacter baumannii and Streptococcus pneumoniae. In addition, the patient's oral hygiene was categorized as poor, with a Beck Oral Assessment Score (BOAS) of 6 (mild oral dysfunction), which represents a significant risk factor for oropharyngeal bacterial colonization contributing to VAP.

The established nursing diagnoses included ineffective airway clearance (D.0001), impaired gas exchange (D.0003), and risk of infection (D.0142). Interventions were focused on respiratory care (I.01014), mechanical ventilation management (I.01013), and oral care (I.11356) as a preventive strategy against infection. The implementation of oral care was carried out routinely as part of infection risk management, utilizing a miswak extract–based approach in this study.

Based on the case, the patient received nursing care over three consecutive days. For effective and systematic outcomes, prior to implementing oral care, the researcher conducted an assessment using the Beck Oral Assessment Score (BOAS) to determine the patient's oral condition and establish the frequency of care in the ICU. On day 1, oral care was provided twice, in the morning and evening. On days 2 and 3, oral care was administered once in the morning. Oral care was performed using a soft-bristled toothbrush with toothpaste containing only natural Miswak extract (non-fluoride) to minimize potential bias in the study. All procedures were carried out in accordance with standard infection control protocols and patient safety guidelines in the ICU.

Table 1. Trends in Oral Health, Infection Parameters, and ICU Severity Scores During Three Days of Oral Care Using Miswak Extract

	Day 1		Day 2		Day 3	
	Pre	Post	Pre	Post	Pre	Post
Beck Oral Assessment Score (BOAS)	7	5	5	5	5	3
Clinical Pulmonary Infection Score (CPIS)	7	7	5	5	3	3
Glasgow Coma Scale (GCS)		4T (Coma)		6T (Stupor)		7T (Somnolent)
Body Temperatures (°C)		37.0		36.4		36.6
Resp total/Resp Support (Breath/min)		14/12		17/12		21/12
Mode Ventilators		SIMV		SIMV		SIMV
FiO_2 (%)		50		50		40
Peep		5		5		5
Leukocytes (µ/L)		20.250		14.620		7.290
Blood pH		7.340		7.371		7.225
HCO3 (mmol/L)		20.0		24.9		17.7
PCO2 (mmol/L)		37.1		44.0		47.8
Sputum		Purulent		Decreased Purulent		No Purulent
Sputum Cultures		Positive Streptococcus Pneumoniae and Acinobacter Baumannii		No Test		No Test
Antibiotic Tests		Resistant to Ceftriaxone		No Test		No Test
APACHE II Scores		35		30		30
SOFA Scores		12		10		9

During the three-day intervention, improvements in mucosal condition and BOAS scores were observed. On day 1, BOAS decreased from 7 (pre-oral care) to 5 (post-oral care), with objective findings showing moist mucosa, pink lips, no tissue desquamation, absence of debris, and minimal saliva production. However, the day-1 CPIS still indicated high risk for VAP. On day 2, the BOAS assessment yielded a score of 5 (no dysfunction), prompting implementation once per day. CPIS improved, decreasing from 7 (high risk) to 5 (low risk), primarily due to reduced purulent secretions.

On day 3, pre-intervention BOAS was 5, and after oral care using Miswak extract, it further decreased to 3 (no dysfunction). CPIS evaluation also declined from 5 (low risk) to 3 (low risk). Analysis indicated that VAP risk is influenced by oral hygiene: poor oral care facilitates bacterial proliferation, and in patients with decreased consciousness on mechanical ventilation, colonized bacteria can easily enter the respiratory tract, leading to ventilator-associated pneumonia (VAP).

In the neurological and physiological parameters, the Glasgow Coma Scale (GCS) showed progressive improvement from 4T (coma) on day 1 to 6T (stupor) on day 2 and 7T (somnolent) on day 3. Body temperature remained relatively stable throughout the observation period, recorded at 37.0°C, 36.4°C, and 36.6°C on days 1 to 3, respectively. Respiratory rate increased gradually from 14 breaths/min on day 1 to 17 breaths/min on day 2 and 21 breaths/min on day 3. The patient was maintained on synchronized intermittent mandatory ventilation (SIMV) mode with a constant positive end-expiratory pressure (PEEP)

of 5 cmH_2O throughout the study period, while the fraction of inspired oxygen (FiO_2) was maintained at 50% on days 1 and 2 and subsequently reduced to 40% on day 3.

In the laboratory and microbiological findings, leukocyte counts demonstrated a continuous decline from 20,250/µL on day 1 to 14,620/µL on day 2 and 7,290/µL on day 3. Arterial blood gas analysis showed pH values of 7.340, 7.371, and 7.225 across days 1 to 3, respectively. Bicarbonate (HCO_3) levels were recorded at 20.0 mmol/L, 24.9 mmol/L, and 17.7 mmol/L, while partial pressure of carbon dioxide (PCO_2) values were 37.1 mmHg, 44.0 mmHg, and 47.8 mmHg, respectively. Microbiological examination of sputum on day 1 identified the presence of Streptococcus pneumoniae and Acinetobacter baumannii, whereas no additional cultures were performed on days 2 and 3. Antibiotic sensitivity testing conducted on day 1 revealed resistance to ceftriaxone.

Regarding severity of illness scores, the Acute Physiology and Chronic Health Evaluation II (APACHE II) score decreased from 35 on day 1 to 30 on days 2 and 3. Similarly, the Sequential Organ Failure Assessment (SOFA) score showed a progressive decline from 12 on day 1 to 10 on day 2 and 9 on day 3.

Discussions

In this case, the patient received structured nursing care over three consecutive days, with oral care frequency guided by initial assessment using the Beck Oral Assessment Score (BOAS). Care involved toothbrushing with a soft-bristled brush and non-fluoride toothpaste containing only natural Miswak extract, minimizing potential study bias and represents the unique method of this study. While the results demonstrate progressive improvement in both BOAS and Clinical Pulmonary Infection Score (CPIS), a more critical interpretation highlights not only what changed, but why and how these changes occurred within the context of critical care nursing practice.

From an analytical perspective, the observed improvement can be explained through the pathophysiological mechanism underlying ventilator-associated pneumonia (VAP). Critically ill patients in ICU settings experience impaired cough reflexes, reduced salivary flow, and prolonged intubation, all of which contribute to rapid colonization of pathogenic microorganisms in the oropharynx [22], [23], [24]. Without effective oral hygiene, this colonization becomes a primary reservoir for microaspiration into the lower respiratory tract [25], [26].

These findings align with previous studies showing oral hygiene significantly decreases VAP incidence. Yunus et al. [27] reported VAP incidence in the intervention group decreased from 85.7% to 0% following oral hygiene implementation, while [28] found 100% of respondents remained free of VAP post-intervention ($p = 0.000$). Randomized controlled trials by Irani et al. [29] demonstrated that Miswak extract prevented VAP occurrence (0%)

compared to 17.1% in chlorhexidine groups (p = 0.01), indicating comparable or superior efficacy. Therefore, the reduction in BOAS scores from 7 to 3 across three days reflects not merely improved oral cleanliness, but a disruption of the microbial reservoir that contributes directly to VAP development.

The gradual decline in CPIS (from 7 to 3) further supports this mechanism. Importantly, the lag between oral condition improvement (BOAS) and infection risk reduction (CPIS) suggests a causal pathway: improved oral hygiene precedes and contributes to decreased pulmonary infection risk. This temporal relationship aligns with critical care theory emphasizing prevention-focused interventions, where early nursing actions modify downstream clinical outcomes. In this context, oral care is not a routine task but a targeted preventive intervention grounded in evidence-based nursing (EBN).

The effectiveness of Miswak extract can be interpreted through its bioactive components and their interaction with ICU-related pathogens. Benzyl isothiocyanate disrupts Gram-negative bacterial membranes, which is particularly relevant given that VAP pathogens such as Pseudomonas aeruginosa and Klebsiella pneumoniae dominate ICU infections [30], [31]. Meanwhile, flavonoids inhibit bacterial protein synthesis, reducing colonization by Gram-positive organisms such as Staphylococcus aureus [32], [33]. This dual antimicrobial action explains the observed reduction in purulent secretions by day 2 and the stabilization of oral condition despite reduced frequency of care.

From a nursing science perspective, these findings illustrate the principle of dose-response adaptation. On day 1, oral care was performed twice daily due to poorer baseline oral condition. As the patient improved, the frequency was reduced to once daily without compromising outcomes. This demonstrates clinical decision-making based on continuous assessment, a core component of ICU nursing competency. It also reflects individualized care planning rather than rigid protocol adherence, which is a key element of patient-centered care in critical settings.

Linking these findings to broader evidence-based nursing frameworks, the intervention supports the integration of best available evidence, clinical expertise, and patient condition [26]. Previous studies and meta-analyses consistently report that oral hygiene interventions reduce VAP incidence [34], but this case adds practical insight into implementation dynamics—specifically, how assessment tools like BOAS can guide frequency and intensity of care. This reinforces the role of nurses as critical decision-makers who translate research into bedside practice [35].

Clinically, the use of Miswak extract offers an important implication for ICU practice, particularly in resource-limited settings. Compared to chlorhexidine, which is commonly used but associated with potential side effects such as mucosal irritation and altered taste, Miswak

demonstrates a favorable safety profile and comparable antimicrobial efficacy. This positions Miswak as a viable alternative within the framework of safe, cost-effective, and culturally adaptable nursing interventions [36], [37], [38].

However, it is also important to critically acknowledge that the improvement observed may not be solely attributable to Miswak. Factors such as overall ICU care quality, ventilator management, suctioning practices, and patient immune response may have contributed to the outcomes. This highlights the multifactorial nature of VAP prevention and underscores the importance of integrating oral care into a broader VAP prevention bundle rather than viewing it as a standalone intervention [37], [38], [39].

Overall, the findings demonstrate that Miswak-based oral care contributes to improved oral health and reduced VAP risk through disruption of microbial colonization and prevention of aspiration-related infection. More importantly, it illustrates how systematic assessment, evidence-based intervention, and adaptive clinical decision-making work synergistically in ICU nursing practice [17], [37], [38]. Strengthening oral care protocols using validated tools and biologically active agents such as Miswak can enhance patient outcomes while reinforcing the critical role of nurses in infection prevention and patient safety [34], [40].

Conclusion

Oral care using Miswak (Salvadora persica L.) extract effectively reduced the risk of ventilator-associated pneumonia (VAP) in Mr. N, demonstrated by a significant decrease in CPIS scores and improved oral mucosa over three days. The intervention highlights the critical role of maintaining oral hygiene in preventing VAP among mechanically ventilated patients. Miswak provides a safe, low-cost, and minimally invasive preventive strategy suitable for ICU settings, with the added benefit of reducing bacterial colonization in the oral cavity. Future studies should involve larger ICU populations to systematically evaluate Miswak's effectiveness, strengthen its evidence base, and support its integration into standard oral care protocols for critically ill patients, emphasizing proactive VAP prevention and patient safety.

Limitation and Suggestions

This study is limited by its single-case design, which restricts the generalizability of the findings. The evaluation was based on short-term clinical indicators (CPIS and BOAS) without long-term follow-up, and no control group was used to compare miswak extract with standard oral care methods. Despite these limitations, the findings highlight the importance of routine oral care and oral hygiene monitoring in preventing Ventilator-Associated Pneumonia (VAP). Miswak (Salvadora persica L.) shows potential as a cost-effective, safe, and culturally acceptable alternative for oral care in mechanically ventilated patients. Future studies are recommended to include larger sample sizes, controlled study designs, and longer observation

periods to better evaluate the effectiveness of miswak extract and strengthen the evidence for its clinical application.

Conflict of Interest

The authors declared that there is no conflict of interest.

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