

Advancements in Oral Hygiene Practices for the Prevention of Ventilator-Associated Pneumonia

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Abstract: This review assesses the impact of oral hygiene interventions on preventing Ventilator-Associated Pneumonia (VAP) in ICU patients. It highlights the efficacy of chlorhexidine, povidone-iodine, sodium bicarbonate, and traditional Chinese medicine (TCM) in reducing the incidence of VAP by minimizing oral bacterial colonization. Chlorhexidine is notably effective at both high and low concentrations, while povidone-iodine offers strong bactericidal properties. Sodium bicarbonate shows potential, particularly for neonatal care, and TCM preparations emerge as beneficial with minimal side effects. Mechanical methods like toothbrushing and irrigation are also emphasized for their role in enhancing oral cleanliness. The review advocates for a multimodal oral care approach to significantly lower VAP risk, indicating a pressing need for standardized care protocols and further research to optimize preventive strategies in mechanically ventilated patients.

Ventilator-Associated Pneumonia (VAP) emerges as a significant concern within intensive care, manifesting in patients who have been mechanically ventilated via intubation or tracheostomy for more than 48 hours, or within 48 hours following extubation. This condition is notably one of the more common complications faced in such settings^[1]. The inhalation of bacteria from the oropharyngeal region, a common site for bacterial colonization, is identified as a key risk factor for the development of VAP. Adopting rigorous oral hygiene protocols has proven to be an effective preventative measure against bacterial colonization, thus mitigating the risk of VAP. This review delves into the efficacy of various oral hygiene approaches in combating VAP, intending to serve as a solid base for future clinical studies.

1. Comparative Effectiveness of Oral Hygiene Solutions in VAP Prevention

1.1 Chlorhexidine

Composed of chlorhexidine gluconate and metronidazole, chlorhexidine stands out as a potent antimicrobial agent effective against a broad spectrum of microorganisms. Its main component,

chlorhexidine gluconate, is a powerful disinfectant, while metronidazole targets bacteria within the oral cavity^[2]. Besides its role in combating oral odors, chlorhexidine has been instrumental in reducing the migration of bacteria to the lower respiratory tract, thus lowering infection risks^[3]. Studies by Gao et al^[4] have shown chlorhexidine's superiority over saline in decreasing VAP rates among critically ill patients. A meta-analysis by Guo et al^[5] revealed the significant effectiveness of both high and low chlorhexidine concentrations in preventing VAP, with a preference for lower concentrations due to safety reasons. Further, research by Lu et al^[6] indicated a 2% chlorhexidine solution's effectiveness over a 0.12% solution in VAP prevention. Wei et al^[7] also confirmed that a 2% solution significantly reduces oral bacterial levels and consequently VAP incidences, highlighting the ongoing discussion on the optimal concentration for oral care.

1.2 Povidone-Iodine

Povidone-iodine, a combination of polyvinylpyrrolidone and iodine, exhibits potent bactericidal activity against most clinically relevant bacteria^[8]. Huang et al^[9] observed its significant effect in reducing VAP instances compared to saline and placebo in patients with head injuries. Similarly, Sun et al^[10] found that gargling with povidone-iodine was more effective than compound borax solutions in VAP prevention, reducing oropharyngeal bacterial colonization. Ding et al^[11] supported povidone-iodine's efficacy in lowering VAP occurrences among intubated patients. A meta-analysis by Emami et al^[12] validated povidone-iodine's role in diminishing VAP rates and shortening ICU stays.

1.3 Sodium Bicarbonate

Sodium bicarbonate forms a mildly alkaline solution when dissolved, fostering an alkaline oral environment that hinders bacterial growth^[13]. Although research predominantly focuses on neonatal care, with limited adult studies, Zheng et al^[14] have shown that a 2.5% sodium bicarbonate solution effectively combats oral infections and VAP in ICU settings. Zhang et al^[15] demonstrated its combined use with 0.9% saline in neonatal care significantly prevents VAP, suggesting its limited efficacy against Gram-negative bacteria, a gap filled by saline.

1.4 Traditional Chinese Medicine (TCM) Preparations

Incorporating TCM into oral care for its antibacterial properties and minimal side effects is gaining traction^[16]. Zhu et al^[16] compared chlorhexidine with TCM in ICU patients, finding TCM effective against oropharyngeal bacterial colonization and VAP caused by Gram-negative bacteria. Liao et al^[17], using San Huang Xie Xin Tang, reported reductions in VAP occurrences and improvements in oral health. Liang et al.^[18] showed that TCM components like honeysuckle and baical skullcap effectively reduce oral complications and bacterial load.

2. The Impact of Various Oral Hygiene Methods on Preventing VAP

2.1 Irrigation Method

The irrigation method, which uses water flow to cleanse the oral cavity of debris, secretions, and bacteria, has proven effective in VAP prevention. Gong Mingna's research^[19] highlights the use of saline for mouth irrigation in tandem with suction, significantly reducing bacterial colonization and VAP incidents, and thereby shortening ICU stays. Zhang Zhiying's study^[20] underscores the superior efficacy of irrigation over traditional cotton ball wiping in diminishing oral bacterial load and VAP occurrence, though it necessitates multiple personnel to ensure safety and efficacy.

2.2 Brushing with Irrigation

Employing toothbrushes, particularly when combined with chlorhexidine irrigation, stands out as a prime strategy for dental plaque control and VAP prevention^[21]. Zeng Liming's findings^[22] illustrate the benefits of this method in reducing oral bacterial content, enhancing oral health, and thereby lowering VAP rates. Xia Yu's comparison^[23] further confirms the effectiveness of suction toothbrushing followed by irrigation, showcasing a notable decrease in VAP incidence in the study group.

2.3 Wiping Method

Traditional wiping, utilizing chlorhexidine-soaked cotton balls, swabs, or gauze, remains a cornerstone of oral care, effectively removing plaque and reducing bacterial proliferation^[24]. Zhang Lixia's application^[24] of this method has shown significant benefits in improving oral hygiene and decreasing VAP rates. Wang Yaning's approach^[25], comparing wet and dry-wet cotton ball wiping, highlights the dry-wet method's efficiency in clearing oral bacteria, underscoring the need for further investigation into the optimal wiping frequency.

2.4 Wiping Combined with Irrigation

Integrating wiping with irrigation offers a comprehensive approach to oral cleanliness, particularly effective in managing patients with substantial or sticky oral secretions. Li Hui's comparison^[26] demonstrates the combined method's superiority in significantly reducing VAP incidence and hospitalization duration compared to wiping alone. Similarly, Sun Xiaowen's meta-analysis^[27] supports the combined approach's enhanced effectiveness in improving oral hygiene and reducing VAP risk, suggesting a promising area for further clinical research and practice optimization.

3. Conclusion

Oral care in China is still in an exploratory phase, lacking unified guidelines. Identifying effective methods to clean the mouth, reduce bacterial colonization, and decrease VAP incidence remains a clinical priority. Currently, discussions on oral hygiene primarily focus on care methods and solutions, with a need for innovative approaches. As VAP can extend mechanical ventilation and hospitalization durations, increase medical costs, and mortality rates, continually exploring optimal oral hygiene strategies is crucial for improving patient outcomes.

References

- [1] Yu Cuixiang, Wang Xiyan. "Interpretation of the Guidelines for the Diagnosis and Treatment of Hospital-Acquired Pneumonia and Ventilator-Associated Pneumonia in Chinese Adults (2018 Edition)" [J]. *China Medical Journal*, 2021, 56(9): 951-953.
- [2] Yang Ting, Nan Guoli, Yu Bo, et al. "Feasibility Study of Replacing Hydrogen Peroxide with Compound Chlorhexidine for Oral Care in Intubated Patients" [J]. *Advances in Modern Biomedicine*, 2013, 13(19): 3741-3743.
- [3] Tang Huiting, Lu Huijuan, Yang Xiaoli, et al. "Meta-Analysis on the Effectiveness of Chlorhexidine in Oral Care for Critically Ill Intubated Patients" [J]. *Journal of Nursing*, 2013, 28(03): 78-81.
- [4] Gao Jie, Chen Zhen, Guo Shasha. "Short-Term Effectiveness of Chlorhexidine Oral Care in Preventing Ventilator-Associated Pneumonia in Critical Patients" [J]. *Modern Medicine & Health*, 2019, 35(04): 602-604.
- [5] Guo Yi, Zhu Cuiqi, Guo Jing, et al. "Meta-Analysis on the Effectiveness of Chlorhexidine for Oral Care in Preventing VAP in Mechanically Ventilated Patients" [J]. *Evidence-Based Nursing*, 2022, 8(04): 427-433.
- [6] Lu Wuying, Yong Xuan, Sun Simei. "Application of Different Concentrations of Chlorhexidine Oral Care Solution in Patients with Oral Endotracheal Intubation" [J]. *Chinese Journal of Infection Control*, 2016, 15(08): 579-582.
- [7] Wei Zongting, Wang Chuanxiu, Sun Liang, et al. "Observation on the Effectiveness of 2% Chlorhexidine Oral Care

- Solution in Preventing Ventilator-Associated Pneumonia" [J]. *Nursing Research*, 2014, 28(08): 984-985.
- [8] Hu Zhaoyong, Qu An, Cong Xinde. "Clinical Application of Povidone-Iodine" [J]. *Journal of Chinese Hospital Pharmacy*, 1998, (07): 19-20.
- [9] Huang Lipeng, Jiang Xuli. "Analysis of the Effectiveness of Povidone-Iodine Oropharyngeal Disinfection in Preventing Ventilator-Associated Pneumonia" [J]. *Chinese Journal of Preventive Medicine*, 2018, 19(05): 398-400.
- [10] Sun Danying, Li Luoyao, Yang Dongmei. "Comparison of the Effectiveness of Povidone-Iodine Gargle Solution and Compound Borax Gargle Solution in Preventing VAP in Mechanically Ventilated Patients and Their Impact on Bacterial Colonization" [J]. *General Nursing*, 2023, 21(18): 2534-2537.
- [11] Ding Ruixue, Zhao Huili, Peng Yuanzheng, et al. "The Effectiveness of Povidone-Iodine Gargle Solution in Oral Health Management for Patients with Tracheal Intubation in the Intensive Care Unit" [J]. *Jiangsu Healthcare*, 2023, 25(03): 178-180.
- [12] Emami Zeydi A, Parvizi A, Haddadi S, et al. "Effect of Oral Care with Povidone-Iodine in the Prevention of Ventilator-Associated Pneumonia: A Systematic Review and Meta-Analysis" [J]. *Archives of Academic Emergency Medicine*, 2023 Apr 4; 11(1): e31.
- [13] Chen Yu. "Evaluation of the Nursing Effectiveness of Sodium Bicarbonate Oral Care in Preventing Ventilator Pneumonia in Neonates" [J]. *Everyone's Health (Academic Edition)*, 2015, 9(20): 21-22.
- [14] Zheng Xiurong, Guo Yanmei. "Analysis of the Effect of Sodium Bicarbonate Oral Care Intervention in Preventing Oral Infections in ICU Patients" [J]. *International Medicine and Health Guidance News*, 2019, 17(08): 82-84.
- [15] Zhang Ru, Zhang Jing, Ren Borong, et al. "Observation on the Effectiveness of Combining 0.9% Saline and 2.5% Sodium Bicarbonate for Oral Care in Preventing Ventilator-Associated Pneumonia in Neonates" [J]. *Guizhou Medicine*, 2022, 46(11): 1837-1838.
- [16] Zhu Yanan, Pang Xufeng, Sun Yunbo. "Clinical Observation of Traditional Chinese Medicine Preparations on Oropharyngeal Bacterial Decolonization and Prevention of Ventilator-Associated Pneumonia" [J]. *World Traditional Chinese Medicine*, 2023, 18(15): 2185-2189.
- [17] Liao Feng, Lin Bo, Zhang Qijun, et al. "Study on the Preventive Effects of San Huang Xie Xin Tang Oral Care Solution on Ventilator-Associated Pneumonia" [J]. *Journal of External Therapy of Traditional Chinese Medicine*, 2022, 31(05): 107-109.
- [18] Liang Yandong, Zhao Liyun. "Observation of the Effect of Traditional Chinese Medicine Oral Care Solution on Oral Care in ICU Patients with Tracheal Intubation" [J]. *International Medicine and Health Guidance News*, 2020, 26(13): 1951-1954.
- [19] Gong Mingna. "The Effectiveness of Different Oral Care Methods in Preventing Ventilator-Associated Pneumonia" [J]. *Everyone's Health (Academic Edition)*, 2015, 9(15): 246.
- [20] Zhang Zhiying, Zhang Xiaoying, Ding Yulan. "Comparison of the Effects of Different Oral Care Methods in Preventing Ventilator-Associated Pneumonia" [J]. *Northwest Defense Medical Journal*, 2019, 40(09): 544-548.
- [21] Zhang Yanling, Zhang Xinkui. "Clinical Evaluation of the Toothbrushing Effectiveness of Manual Toothbrushes with Different Bristle Materials" [J]. *Journal of Practical Oral Medicine*, 2018, 34(1): 117-120.
- [22] Zeng Liming, Tang Keling. "The Role of Improved Oral Care Methods in Enhancing Oral Health and Preventing Ventilator-Associated Pneumonia in ICU Mechanically Ventilated Patients" [J]. *Chinese Rural Medicine*, 2023, 30(16): 59-60+62.
- [23] Xia Yu, Min Zhaoqin. "Application of Improved Oral Care Methods in Mechanically Ventilated Patients" [J]. *Heilongjiang Medicine*, 2022, 46(03): 374-375+378.
- [24] Zhang Lixia, Yang Qing. "Evaluation of the Application Value of Chlorhexidine Cotton Ball Wiping Method in Oral Care for Patients with Tracheal Intubation" [J]. *International Medicine and Health Guidance News*, 2020, 18(22): 93-94.
- [25] Wang Yaning, Wang Hongyan, Zhai Liping, et al. "Study on the Prevention of Ventilator-Associated Pneumonia with the Dry and Wet Cotton Ball Wiping Method for Oral Care" [J]. *Journal of Nursing*, 2013, 28(11): 15-16.
- [26] Li Hui. "Observation on the Effects of Two Oral Care Methods in Preventing Ventilator-Associated Pneumonia in ICU Comatose Patients" [J]. *Health Vocational Education*, 2015, 33(05): 150-151.
- [27] Sun Xiaowen, Jiang Rong, Xu Anqi, et al. "Meta-Analysis on the Application Effect of Oral Irrigation Nursing Method in Patients with Oral Endotracheal Intubation" [J]. *Contemporary Nurse (Late Edition)*, 2020, 27(05): 42-44.