

*Review Article*

## The Effectiveness of Combination Toothbrushing and Suctioning for Oral hygiene Protocol in Reducing VAP in Intubated Patient: A Systematic Review of Randomized Controlled Trials

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**Abstract:** Intubated patients admitted to intensive care units (ICUs) are highly susceptible to impaired oral immunity, resulting in rapid oral microbial colonization, dental plaque accumulation, dry mouth, and other oral health problems. Poor oral hygiene is strongly associated with ventilator-associated pneumonia (VAP), a leading cause of morbidity and mortality among mechanically ventilated patients. This study aimed to evaluate the effectiveness of combining toothbrushing and suctioning during oral hygiene in reducing the incidence of VAP in intubated patients. A systematic review was conducted using the PICO framework and PRISMA guidelines to identify and analyze relevant studies. The findings showed that oral hygiene interventions included swabbing, toothbrushing, suctioning, mouth rinsing, and oral moisturizing. Although not all reviewed studies demonstrated a statistically significant reduction in VAP incidence with the combined use of toothbrushing and suctioning, several reported lower VAP rates compared with swabbing alone. Variations in outcomes were likely influenced by differences in oral care protocols, mouthwash solutions, toothbrush types, suction devices, and intervention frequency. Overall, comprehensive oral hygiene incorporating toothbrushing and suctioning appears to improve oral health and may contribute to reducing VAP risk when supported by standardized evidence-based nursing protocols.

**Keywords:** Intubated Patient; Oral Hygiene; Suctioning; Toothbrushing; VAP.

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### 1. Introduction

Patients admitted to the Intensive Care Unit (ICU) are those in a critical condition who are generally fitted with an endotracheal tube (ETT) and placed on mechanical ventilation due to their inability to breathe unaided as a result of specific medical conditions (Zhao et al., 2020). Intubated patients on mechanical ventilation have a high mortality rate, not only due to their underlying illness but also as a result of nosocomial infections (Richards et al., 1999). In intubated patients, oral immunity tends to decline, leading to rapid colonization by microorganisms in the mouth, which can result in dental plaque, dry mouth and other oral hygiene problems. These patients require assistance from nurses to meet their basic needs, one of which is oral hygiene.

Oral hygiene is a form of personal hygiene aimed at maintaining the health of the mouth, teeth and orofacial structures. Maintaining oral hygiene is vital to overall human health and enables people to carry out their daily activities (World Health Organization, 2023). For dependent patients, such as those in the ICU, oral hygiene care must be carried out by healthcare professionals, including nurses, to prevent aspiration of oral cleansing fluids. Routine oral hygiene care is carried out to remove plaque and debris and to replace the function of saliva in moistening and cleansing the oral cavity (Zhao et al., 2020). Poor oral hygiene can lead to serious complications such as pneumonia and other infections (Murray & Scholten, 2018). Oral hygiene in intubated patients is closely linked to the incidence of

ventilator-associated pneumonia (VAP), which is the most common cause of morbidity and mortality in the ICU. VAP is defined as pneumonia occurring within 48 hours in patients on mechanical ventilation (Wagh & Acharya, 2009). VAP leads to prolonged hospital stays and increases mortality to as high as 70% (Micik et al., 2013). The endotracheal tube (ETT) inserted in patients facilitates the entry of bacteria into the patient's respiratory tract, leading to the development of VAP (McHugh et al., 2015). Several studies have investigated the relationship between oral hygiene practices and the incidence of VAP. Research indicates that patients in intensive care units (ICUs) who receive oral hygiene care have a lower incidence of VAP compared to those who do not receive such care (Atashi et al., 2018; de Araújo et al., 2023; Haghighi et al., 2017). Based on research, nurses in intensive care units agree that patients' oral hygiene must be maintained; however, as many as 40.8 per cent of nurses agree that implementing oral hygiene care is difficult (Saddki et al., 2017). Research in Indonesia indicates that 99% of nurses agree that oral hygiene is important for hospital patients and 59.7% of nurses possess good knowledge. However, the implementation of oral hygiene care in the ICU is classified as inadequate at 60% (Setianingsih et al., 2017; Werdani et al., 2021).

Oral hygiene care for patients in the ICU can be carried out using several methods and tools. These include oral hygiene using chlorhexidine solution, swabbing with gauze, toothbrushing (whether manual or electric), petroleum jelly to moisturize the lips, and suction. Suction is carried out to remove fluids, toothpaste and debris from the oral cavity (Zhao et al., 2020). One effective tool for oral hygiene is the toothbrush; when used optimally, it can remove plaque and debris from the oral cavity (Dejuilio et al., 2023). A study indicates that the use of toothbrushing and suctioning during oral hygiene is effective in reducing plaque and lowering the incidence of VAP in patients. However, many nurses still do not use these methods as they find that it difficult to reach out-of-sight areas (Binkley et al., 2004; Dejuilio et al., 2023; Rayanti et al., 2023; Samim et al., 2022). Although there have been numerous clinical studies on the combined use of toothbrushing and suctioning for intubated patients, none have addressed this topic in the form of a systematic review focusing on randomised controlled trials (RCTs). Consequently, the authors are interested in conducting a more in-depth review and further evaluating the effectiveness of the combined use of toothbrushing and suctioning during oral hygiene in reducing the incidence of VAP in intubated patients.

## 2. Methods

### Design

The design of this study is a systematic review. This systematic review was conducted using the Population, Intervention, Comparison and Outcome (PICO) framework. The clinical questions addressed in this study are: intubated patients (P), oral hygiene (I), and reducing the incidence of ventilator-associated pneumonia (O).

### Search Methods

The literature search for this systematic review was conducted in international databases based on clinical questions as well as inclusion and exclusion criteria. The databases used in the literature search were PubMed, ScienceDirect, SAGE Journals, ProQuest, EBSCOHost, ClinicalKey and Cochrane. The literature search in these databases was conducted using the Boolean operators "OR" and "AND" with the following keywords: ("oral hygiene" OR "oral care") AND ("intubation patient" OR "ICU patient" OR "critically ill patient" OR "patient with mechanical ventilator") AND ("reduce VAP"). The articles collected were those published between 2013 and 2023. After gathering articles from various databases, the researchers identified and screened the retrieved articles for relevance based on their titles and abstracts, whilst also checking for duplicates. The researchers then screened the full-text articles against the inclusion and exclusion criteria. Articles meeting the criteria were then selected for review. The selection process for this systematic review was based on the 2020 PRISMA guidelines (Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2020). The PRISMA flow diagram for this systematic review is shown in Figure 1.

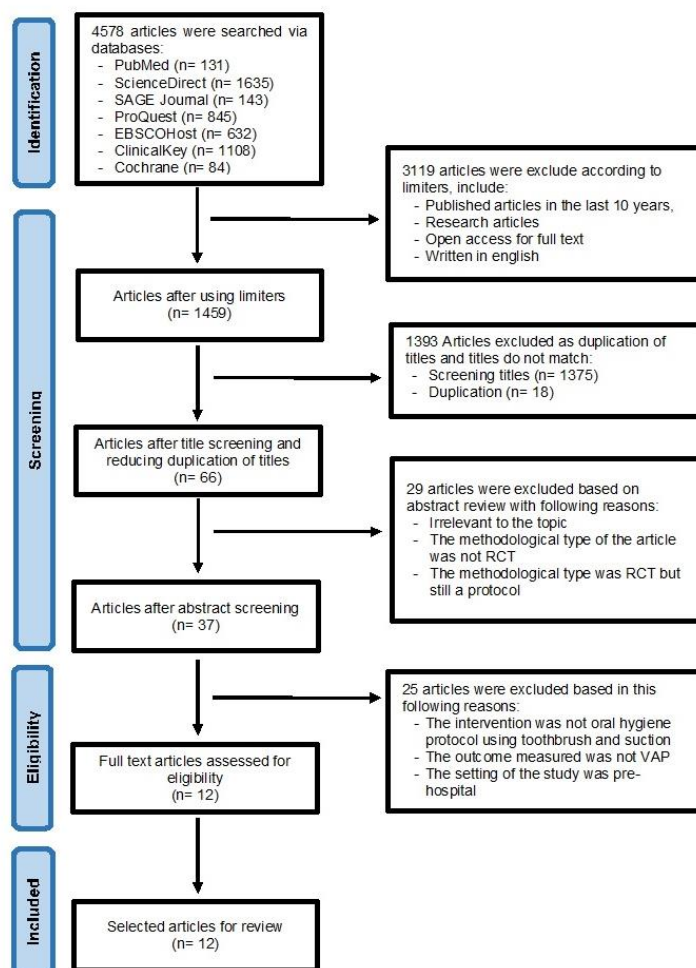


Figure 1. PRISMA Flow Diagram.

### Inclusion and Exclusion Criteria

The inclusion criteria for this systematic review were: articles employing a randomized controlled trial (RCT) study design; articles published between 2013 and 2023 (the last 10 years); articles accessible free of charge (free full text or open access); and interventions consisting of oral hygiene or oral care protocols that included toothbrushing and suctioning. Exclusion criteria included articles not written in English or Indonesian, and those not relevant to the topic of this systematic review.

### Data Extraction

This systematic review aimed to examine the effectiveness of combining toothbrushing and suctioning methods within an oral hygiene protocol for intubated patients in reducing the incidence of VAP. All articles that passed the selection process and were included in the review underwent data extraction, covering the authors, year of publication, country, study design, study objectives, participants, oral hygiene protocol, outcome measures and findings. The data extraction is presented in appendix A.

### Quality Appraisal

The quality of the articles in this systematic review was assessed using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Randomized Controlled Trials (The Joanna Briggs Institute, 2017).

### 3. Result and Discussion

**Table 1.** Data Extraction.

| Author<br>, year /<br>Countr<br>y          | Design/<br>Aim                                                                                                                    | Participant                                                         | Oral<br>hygiene<br>protocol                                                                                                                                                                                                                                                                                                                                   | Outcome<br>measures                                                                            | Results                                                                                                                                                                                                                                                                                       |
|--------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Nasiria<br>ni et<br>al.,<br>2016 /<br>Iran | - R<br>CT,<br>single-<br>blind                                                                                                    | Adult<br>ventilator-<br>dependent<br>patients in<br>ICU<br>(n= 168) | - I<br>nterventi<br>on group:<br>routine<br>oral care<br>with<br>children's<br>soft<br>toothbrus<br>h and<br>distilled<br>water<br>twice<br>daily in<br>the<br>surface of<br>the<br>tongue<br>and teeth,<br>swab the<br>tongue<br>with<br>chlorhexi<br>dine and<br>followed<br>by 20ml<br>of normal<br>saline and<br>deeply<br>suctioned<br>subseque<br>ntly. | The incidence of<br>VAP was<br>determined using<br>CPIS in 2,3,4,5<br>days of<br>intervention. | - 38,6%<br>patient in each<br>group was<br>develop VAP.<br>- The<br>incidence of<br>VAP in the<br>intervention<br>group and<br>control group<br>were respectively<br>4,8% and 6% on<br>the third day,<br>14,3% and 20,2%<br>on the fourth<br>day, and 29,8%<br>and 47,6% on the<br>fifth day. |
|                                            | - A<br>im: to<br>determin<br>e the<br>effect of<br>brushing<br>teeth with<br>distilled<br>water on<br>the<br>incidence<br>of VAP. |                                                                     | - C<br>ontrol<br>group:<br>routine<br>oral care<br>with<br>rinsing<br>the<br>mouth<br>using<br>normal<br>saline,<br>swab and<br>rubbing<br>the<br>surface of<br>the<br>tongue<br>using<br>chlorhexi<br>dine three<br>times a<br>day. This<br>protocol                                                                                                         |                                                                                                | - There<br>was a significant<br>difference in<br>incidence of<br>VAP on day 5<br>between the two<br>group.                                                                                                                                                                                    |

|                                               |                                                                                                                |                           |     |  |                                                                                                                                                                                                                                                          |                                                  |                                                                                                                                               |  |
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|                                               |                                                                                                                |                           |     |  | includes control of endotracheal tube cuff.                                                                                                                                                                                                              |                                                  |                                                                                                                                               |  |
|                                               | - Prospective, RCT, triple-blind                                                                               | P Adult patients (n= 213) | ICU |  | - Intervention group: oral hygiene using small and soft bristles toothbrush with 0,12% chlorhexidine gel every 12 hours in all teeth surface, mucosal surface and tongue, suctioning the secretion used catheter that involved in the toothbrush itself. | VAP was diagnosed on American society guideline. | - VAP occurred in 28 subjects from control group and 17 subjects from intervention group.                                                     |  |
|                                               | - Aim: to verify oral hygiene using toothbrushing with 0,12% chlorhexidine gel can reduce the incidence of VAP |                           |     |  |                                                                                                                                                                                                                                                          |                                                  | - The use of toothbrushing with 0,12% chlorhexidine gel had lower incidence of VAP in the follow up period but not statistically significant. |  |
| <b>De Lacerda Vidal et al., 2017 / Brazil</b> |                                                                                                                |                           |     |  |                                                                                                                                                                                                                                                          |                                                  |                                                                                                                                               |  |
|                                               |                                                                                                                |                           |     |  | - Control group: oral hygiene using swab with 15ml of 0,12% chlorhexidine every 12 hours. The surface of the oral care was as same as in intervention group.                                                                                             |                                                  |                                                                                                                                               |  |
| <b>Zand et al., 2017 / Iran</b>               | - CT, single-blind                                                                                             | R Adult patient (n= 114)  | ICU |  | - First group: oral care protocol                                                                                                                                                                                                                        | VAP incidence was diagnosed using CPIS           | - The incidence of VAP was significantly different                                                                                            |  |

|                            |                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                    |
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| Atashi et al., 2018 / Iran | - A<br>im:<br>compare<br>the effect<br>of two<br>different<br>concentra<br>tions of<br>chlorhexi<br>dine on<br>reducing<br>VAP            | using<br>10ml<br>0,2%<br>chlorhexi<br>dine twice<br>a day<br>- S<br>econd<br>group:<br>oral care<br>protocol<br>using<br>10ml 2%<br>chlorhexi<br>dine twice<br>a day.<br>- O<br>ral care<br>protocol<br>includes<br>subglottic<br>suctionin<br>g,<br>toothbrus<br>hing use<br>soft<br>paediatric<br>toothbrus<br>h for<br>patient<br>with<br>teeth, and<br>swabs for<br>patient<br>without<br>teeth with<br>sterile NS<br>using<br>Bass<br>technique<br>for 1<br>minute. | between the two<br>groups.<br>- The<br>incidence of<br>VAP in 2%<br>chlorhexidine<br>was lower than in<br>0,2%<br>chlorhexidine.<br>- Oropharyngeal<br>adverse effects of<br>chlorhexidine<br>was not<br>significantly<br>difference<br>between the two<br>groups. |
|                            | - P Adult<br>arallel intubated<br>RCT patients in<br>- A ICU<br>im: to (n= 80)<br>investigat<br>e the<br>effect of<br>oral care<br>on VAP | - I The VAP was<br>nterventi assessed using<br>on group: CPIS on the first,<br>oral care third, and fifth<br>protocol days in both<br>including groups.<br>adjusting<br>the<br>pressure<br>of the<br>ETT cuff<br>between<br>20-<br>25mmHg<br>, elevating<br>the bed<br>head<br>from 30°<br>to 40°,<br>suctionin<br>g,                                                                                                                                                    | - There<br>was no<br>significantly<br>difference in<br>mean score of<br>CPIS between<br>the two groups.<br>- The<br>incidence of<br>VAP was lower<br>in intervention<br>group than in<br>control group.                                                            |

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|                                              |                                                              |                                                            |  | toothbrush<br>hing for 2<br>minute<br>using<br>baby<br>toothbrush<br>h and<br>chlorhexi<br>dine<br>0,2%,<br>moisturizi<br>ng gel<br>used in all<br>surfaces<br>of the<br>oral<br>mucosa,<br>gingiva<br>and<br>tongue.<br>The<br>frequency<br>of oral<br>care was<br>determin<br>ed every<br>12, 8, 6,<br>and 4<br>hours<br>based on<br>oral<br>condition<br>that<br>scored<br>using<br>BOAS. |                                                                                                                             |                                                                                                      |  |
|                                              |                                                              |                                                            |  | - C<br>ontrol<br>group:<br>oral care<br>using<br>swab and<br>0,2%<br>chlorhexi<br>dine<br>every 12<br>hours.<br>This<br>protocol<br>includes<br>elevation<br>of the bed<br>head<br>from 30°<br>to 40°.                                                                                                                                                                                       |                                                                                                                             |                                                                                                      |  |
| <b>Khaky<br/>et al.,<br/>2018 /<br/>Iran</b> | - CT<br>- im:<br>investigat<br>e the<br>effect of<br>Nanosil | R Adult<br>intubated<br>in<br>A patients<br>ICU<br>(n= 80) |  | - C<br>ontrol<br>group:<br>oral care<br>with 15ml<br>of 2%<br>chlorhexi<br>dine,                                                                                                                                                                                                                                                                                                             | - The<br>incidence of VAP<br>was measured<br>using MCPIS in<br>first and fifth day.<br>- SOFA<br>and GCS<br>instrument used | - MCPIS<br>score was<br>significantly<br>lower in<br>intervention<br>group than in<br>control group. |  |

|                              |                                                                                                                                     |                                                                                                                                                               |                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                        |
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| Klarin et al., 2018 / Sweden | mouthwash to prevent VAP                                                                                                            | including toothbrushing, suctioning and rubbing the oropharyngeal mucosa 3 times a day for 5 days.                                                            | for severity of diseases                                                                                                                                                                                           | evaluates the                                                                                                                                                                                                                                                                                                                                                                                    | - Oral care with Nanosil solution significantly better than chlorhexidine in reduce the incidence of VAP.              |
|                              |                                                                                                                                     | - Intervention group: oral care with 15ml Nanosil solution including toothbrushing, suctioning and rubbing the oropharyngeal mucosa 3 times a day for 5 days. |                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                  | - The mean score of SOFA and GCS were significantly improve in fifth day.                                              |
| Klarin et al., 2018 / Sweden | - R Adult CT, single-blind                                                                                                          | ill                                                                                                                                                           | - C control group: oral care protocol was performed twice a day, include removing of dental prostheses, suctioning, toothbrushing with toothpaste and swab all the surface of the oral cavity using chlorhexidine. | - Cultures were taken from the oropharynx and trachea on day 2,3,5,7,10,14 and 21.                                                                                                                                                                                                                                                                                                               | - There was no difference impact between the two group about their impact on colonisation pathogenic enteric bacteria. |
|                              | - A aim: to evaluate the effect of oral care using probiotic bacterium Lp299 in reducing enteric bacteria in the oropharynx and VAP |                                                                                                                                                               |                                                                                                                                                                                                                    | - VAP was diagnosed using criteria: infiltrate on chest x-ray combined with at least three of the other four criteria; a purulent tracheal aspirate; positive culture of tracheal aspirates occurring after 48h of mechanical ventilation; temperature higher than 38.0 °C or less than 35.5 °C; and WBC count more than 12 or less than 3 or a rapid increase in WBC count without suspicion of | - No adverse events registered because of the Lp299 oral care solution.                                                |
|                              |                                                                                                                                     |                                                                                                                                                               |                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                  | - VAP was identified in both group, 7 patients in Intervention group and 10 patients in control group.                 |



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|  |  |                                                                                                               |  | <p>- I infection in<br/>nventi another organ.<br/>on group:<br/>oral care<br/>protocol<br/>was<br/>performe<br/>d twice a<br/>day,<br/>include<br/>removing<br/>of dental<br/>prosthese<br/>s,<br/>suctionin<br/>g,<br/>toothbrus<br/>hing with<br/>toothpast<br/>e and<br/>swab all<br/>the<br/>surface of<br/>the oral<br/>cavity<br/>using<br/>Lp299.<br/>This<br/>procedur<br/>e was<br/>done<br/>using 2<br/>gauze<br/>swabs</p> |                                                                                                                                            |                                                                                                                                                                                                                                                                                           |
|  |  | <p>- R Adult trauma<br/>CT, ICU patients<br/>single- on<br/>blind mechanical<br/>ventilators.<br/>(n= 57)</p> |  | <p>- I nventi<br/>on group:<br/>oral<br/>hygiene<br/>care from<br/>nurse<br/>using oral<br/>swabs<br/>with<br/>chlorhexi<br/>dine<br/>0,12%<br/>every 8<br/>hours +<br/>additional<br/>oral<br/>hygiene<br/>care by<br/>dental<br/>hygienists<br/>using<br/>paediatric<br/>toothbrus<br/>hes and<br/>chlorhexi<br/>dine<br/>0,12%<br/>and</p>                                                                                         | <p>- The<br/>incidence of VAP<br/>was assessed over<br/>seven days use<br/>CPIS.<br/>- Oral<br/>health status was<br/>assessed by BOE.</p> | <p>- There<br/>was no VAP<br/>cases in<br/>intervention<br/>group, and there<br/>was 2 cases in the<br/>control group<br/>during the<br/>intervention<br/>period.<br/>- The<br/>BOE scores was<br/>significantly<br/>difference in oral<br/>hygiene in the<br/>intervention<br/>group</p> |

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| <p><b>Haghi ghat et al., 2022 / Iran</b></p> | <p>- Three-group parallel RCT</p> <p>- Aim: to investigate the effect of three oral care protocols on the incidence of VAP in MV patients.</p> | <p>T Adult Mechanically -Ventilated (MV) patients in ICU (n= 71)</p> | <p>F VAP was investigated before, four days after and seven days after the intervention using MCPIS.</p> | <p>- The frequency of VAP in the first group (swab) were higher than the other two groups in the fourth day of the intervention</p> <p>- Using toothbrush in the oral care program can reduce the incidence of VAP</p> <p>- Oral care program with four-times-brushing every 24 hours can be considered the preferred method for reducing the incidence of VAP.</p> |
|                                              |                                                                                                                                                |                                                                      |                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                     |

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| Singh et al., 2022 / India | - CT - im: correlate oral hygiene with or without adjuvant oral care with VAP in ICU patients | R Adult ICU patients with oral ETT in situ (n= 220) | - S tudy group: oral hygiene protocol includes ETT cuff pressure between 20-25mmHg , elevated bed head to 30°-45°, suctionin | - Oral health was assessed at 4, 6, 8, and 12 hours using BOAS - VAP was assessed based on abnormal chest x-rays, fever, chest auscultation, endotracheal culture report and incidence of VAP using CDC guidelines. | - The BOAS scores were significantly lower in group S than in group C. its mean that the oral health in group S was better than in group C. - Normal chest x-ray was observed for significantly higher proportion in group S |
|                            |                                                                                               |                                                     |                                                                                                                              |                                                                                                                                                                                                                     |                                                                                                                                                                                                                              |

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| Izadi et al., 2023 / Iran | - R CT, double-blind - A im: to compare oral care with chlorhexidine (CHG) and ozonated water (OZW) to reduce the risk of VAP. | Adult patient on MV in ICU n= 78 | - I nterventi on group: oral care routine every 8 hours (with children's soft-bristle toothbrush and toothpaste) and after that all surface of oral cavity were washed with 15ml OZW. Oral care protocol includes elevated                                                    | - VAP was diagnosed with CPIS in day 1, 3 and 5. | - OZW was significantly more effective to reduce the risk of VAP compared to CHG. - In both groups, the CPIS scores showed significant differences at times. - In all 3 times, the CPIS scores were not significantly different.                                                                                                             |
|                           |                                                                                                                                |                                  |                                                                                                                                                                                                                                                                               |                                                  |                                                                                                                                                                                                                                                                                                                                              |
|                           |                                                                                                                                |                                  | g, toothbrushing using a baby brush with antimicrobial chlorhexidine 0,2%, moisturizing gel (aloe vera, peppermint oil, petroleum jelly) - C ontrol group: oral care using swab with chlorhexidine 0,2% only, without toothbrushing and moisturizing gel and petroleum jelly. |                                                  | compared to group C. - ETI culture in group S was found to be sterile while in group C was found to be infected which was significant statistically. - The prevalence of VAP was significantly higher in group C compared with the prevalence of VAP in group S. - Mortality rate was significantly higher in group C compared with group S. |

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|                          |  |     |                                                                                                            | head bed to 30°, hyper-oxygenated with 100% oxygen if needed, suctioning, ETT cuff pressure was set at 25mmHg - C                                                                     |                                                                                 |                                                                                                 |  |
|                          |  |     |                                                                                                            | ontrol group: oral care routine every 8 hours (with children's soft bristle toothbrush and toothpaste) and after that all surface of oral cavity were washed with chlorhexidine (CHG) |                                                                                 |                                                                                                 |  |
|                          |  | - P | Adult critically ill patients with MV in ICU (n= 76)                                                       | - C                                                                                                                                                                                   | - VAP was diagnosed based on temperature, secretion, leukocyte and chest x-ray. | - The incidence of VAP in the control group was 55,26% and in the observation group was 21,05%. |  |
|                          |  | - A | im: to explore the effect of comprehensive nursing intervention on mechanically ventilated patients in ICU |                                                                                                                                                                                       |                                                                                 | - Oral odour, dental plaque in observation group was significantly lower than in control group  |  |
| Lei et al., 2023 / China |  |     |                                                                                                            | ontrol group: daily oral care twice daily use 0,12% chlorhexidine and a modular programme including toothbrushing, oral suctioning and mouth/lip moisturisation.                      |                                                                                 |                                                                                                 |  |
|                          |  |     |                                                                                                            | - O                                                                                                                                                                                   | bservation group:                                                               |                                                                                                 |  |

|                                          |                                                                                              |                                                   |                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                         |                           |                  |                                                                                                                                                                                                                                                                                         |
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| <p><b>Karimi et al., 2023 / Iran</b></p> | <p>- Multicentre RCT, double-blind</p>                                                       | <p>M Adult intubated patients in ICU (n= 200)</p> | <p>- Intervention group: dynamic supervised oral health care protocol including staff handwash and wear gloves, examination of the mouth and report any abnormal finding, increase</p> | <p>oral comprehensive nursing intervention twice daily. Secretion cleaning by suction, assisting expectoration, repeated rising and scrubbing using cotton ball and NS, toothbrushing with 0,02% chlorhexidine or 1,5% hydrogen peroxide or 2% sodium bicarbonate or 1% sterile water or NS 0,9% for those not using chlorhexidine.</p> | <p>VAP diagnosed CPIS</p> | <p>was using</p> | <p>- VAP incidence in intervention group was lower than in control group.</p> <p>- The chance of VAP occurrence in intervention group was 33,3 times lower than in control group.</p> <p>- Dynamic supervised oral health protocol is more effective than standard oral care in ICU</p> |
|                                          | <p>- Aim: to determine the effectiveness of an oral health protocol in prevention of VAP</p> |                                                   |                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                         |                           |                  |                                                                                                                                                                                                                                                                                         |

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cuff  
pressure  
of ETT  
to >  
20mmHg  
, elevated  
bed head  
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### Characteristic of Articles

A total of 12 articles were reviewed in this systematic review. All articles were randomized controlled trials (RCTs); one article used triple-blinding (Vidal et al., 2017), two articles used double-blinding (Izadi et al., 2023; Karimi et al., 2023), and four articles used single-blinding (Choi et al., 2022; Klarin et al., 2018; Nasiriani et al., 2016; Zand et al., 2017), one article stated that the blinding process was not applicable in the study (Haghighat et al.,

2022) and four others did not provide detailed information regarding the blinding process (Atashi et al., 2018; Khaky et al., 2018; Lei et al., 2023; Singh et al., 2022). The studies covered in the articles were predominantly (7 articles) conducted in Iran; other countries included Brazil, Sweden, the Republic of Korea, India and China. The population across all reviewed articles consisted of intubated adult patients in the ICU. The study with the largest number of participants involved 220 participants (Singh et al., 2022).

### **Oral Hygiene Protocol**

All oral hygiene protocols used in the articles involved toothbrushes and suction. However, not all articles identified toothbrushing and suctioning as the primary focus of their research. Seven articles focused on comparing oral hygiene protocols using toothbrushing and suctioning with other methods such as swabbing (Atashi et al., 2018; Choi et al., 2022; Haghighat et al., 2022; Karimi et al., 2023; Nasiriani et al., 2016; Singh et al., 2022; Vidal et al., 2017). One article discussed the effects of a comprehensive nursing intervention regarding oral hygiene in intubated patients (Lei et al., 2023). Other articles discuss comparisons of the effectiveness of oral hygiene using chlorhexidine solution versus other mouthwashes such as ozonated water or nanosil, or compare the effects of different concentrations of chlorhexidine solution in reducing VAP (Izadi et al., 2023; Khaky et al., 2018; Zand et al., 2017).

### **VAP Measurements and Incidences**

The incidence of VAP was the primary outcome in this study. All the articles we reviewed examined the effectiveness of oral hygiene protocols in reducing the incidence of VAP. In the majority of the articles, the incidence of VAP was measured or diagnosed using the Clinical Pulmonary Infection Score (CPIS) (Atashi et al., 2018; Choi et al., 2022; Izadi et al., 2023; Karimi et al., 2023; Nasiriani et al., 2016; Zand et al., 2017). In addition to the CPIS, other instruments that were used included the Modified Clinical Pulmonary Infection Score (MCPIS) (Haghighat et al., 2022; Khaky et al., 2018), American thoracic society guideline (Vidal et al., 2017), Centers for Disease Control and Prevention (CDC) guidelines (Singh et al., 2022), and other criteria (Lei et al., 2023; Klarin et al., 2018).

All articles indicate that an oral hygiene protocol incorporating toothbrushing and suctioning can reduce the incidence of VAP in intubated patients (Atashi et al., 2018; Choi et al., 2022; De Lacerda Vidal et al., 2017; Haghighat et al., 2022; Izadi et al., 2023; Karimi et al., 2023; Khaky et al., 2018; Klarin et al., 2018; Lei et al., 2023; Nasiriani et al., 2016; Singh et al., 2022; Zand et al., 2017). However, two of these studies found no statistically significant difference in the incidence of VAP between oral hygiene using toothbrushing and suctioning versus oral hygiene using swabbing (Atashi et al., 2018; Vidal et al., 2017).

### **Discussion**

Oral hygiene protocols are one of the measures that nurses can implement to prevent or reduce the incidence of VAP in intubated patients. This is because oral hygiene can reduce the accumulation and colonization of bacteria in the oropharynx, which is one of the causes of VAP (Nobahar et al., 2016). Several oral hygiene methods that can be carried out by nurses include swabbing, toothbrushing, suctioning, rinsing and moisturizing. These methods can be carried out individually. However, when a combination of these methods is used for oral hygiene, it can form an effective strategy or protocol (Haghighat et al., 2022; Karimi et al., 2023). One effective combination of oral hygiene methods is toothbrushing and suctioning. The use of toothbrushing and suctioning in an oral hygiene protocol is significantly more effective at reducing the incidence of VAP compared to other methods (Choi et al., 2022; Haghighat et al., 2022; Karimi et al., 2023; Khaky et al., 2018; Klarin et al., 2018; Lei et al., 2023; Nasiriani et al., 2016; Singh et al., 2022; Zand et al., 2017). This finding is aligned with one study which states that oral care involving toothbrushing and suctioning of the entire oral cavity every 4 hours over a 24-hour period can effectively reduce the incidence of VAP (Hutchins et al., 2009).

Not all articles indicate that the combination of toothbrushing and suctioning significantly reduces the incidence of VAP. Some articles indicate that the oral hygiene protocol group using toothbrushing and suctioning had a lower incidence of VAP compared with the oral hygiene group using swabbing. However, these results did not show a statistically significant difference (Atashi et al., 2018; Izadi et al., 2023; Vidal et al., 2017). This might be because, when performing oral hygiene on intubated patients, toothbrushing and suctioning cannot be used in isolation. The choice of oral hygiene solution may also contribute to this. There are various types of oral hygiene solutions, such as the gold standard chlorhexidine, which is available in several concentrations including 0.02%; 0.12%; 0.2%; and 2%, 0.9%



normal saline, sterilized water, nanosil solution, ozonated water, hydrogen peroxide, sodium bicarbonate, and Lp299 oral decontamination solution (Atashi et al., 2018; Choi et al., 2022; De Lacerda Vidal et al., 2017; Haghighat et al., 2022; Izadi et al., 2023; Karimi et al., 2023; Khaky et al., 2018; Klarin et al., 2018; Lei et al., 2023; Nasiriani et al., 2016; Singh et al., 2022; Zand et al., 2017). These findings are aligned with research showing that the use of toothbrushing and suctioning with chlorhexidine solution has no effect on reducing the incidence of VAP (Haghighi et al., 2017).

The choice of toothbrush type may also contribute to the effectiveness of the oral hygiene protocol. There is a wide variety of toothbrushes available on the market; however, the types recommended for intubated patients are small pediatric toothbrushes with soft bristles and impregnated toothbrushes (Atashi et al., 2018; Choi et al., 2022; De Lacerda Vidal et al., 2017; Haghighat et al., 2022; Izadi et al., 2023; Karimi et al., 2023; Khaky et al., 2018; Klarin et al., 2018; Lei et al., 2023; Nasiriani et al., 2016; Singh et al., 2022; Zand et al., 2017). This type of toothbrush was selected to facilitate the toothbrushing process and enable access to deeper areas. This is because, when using an adult toothbrush, it is difficult to insert the brush into the patient's mouth due to the presence of ETTs, which make it difficult to open the patient's mouth (Choi et al., 2022).

The type of suction system selected in the reviewed articles was a disposable suction catheter, whether open or closed. The open-system suction is used for suctioning the oral cavity; this suction device is positioned near or next to the head of the toothbrush so that fluids can be suctioned immediately during toothbrushing. Closed-system suction is used for suctioning in the oropharyngeal region; this suction device is usually integrated with a tube connecting the ETT to the mechanical ventilator (Atashi et al., 2018; Choi et al., 2022; De Lacerda Vidal et al., 2017; Haghighat et al., 2022; Izadi et al., 2023; Karimi et al., 2023; Khaky et al., 2018; Klarin et al., 2018; Lei et al., 2023; Nasiriani et al., 2016; Singh et al., 2022; Zand et al., 2017). Furthermore, in another study, the type of suction used was one in which the catheter was attached directly to the toothbrush commonly known as a suction toothbrush (Vidal et al., 2017). Several studies suggest that the use of suction toothbrushes as a tool for oral hygiene is effective in reducing plaque and lowering the incidence of VAP in patients. However, many nurses still do not use them due to a lack of availability in hospitals, the perceived difficulty in reaching hard-to-see areas, and the fact that the brush head is quite large, making it difficult to insert into the mouth of an intubated patient (Binkley et al., 2004; Choi et al., 2022; Dejuilio et al., 2023; Samim et al., 2022).

#### 4. Conclusion

Oral hygiene protocols have been shown to reduce the incidence of VAP in intubated patients. One effective method involves a combination of toothbrushing and suctioning. Based on this systematic review of randomized controlled trials, it can be concluded that oral hygiene using a combination of toothbrushing and suctioning can effectively reduce the incidence of VAP in intubated patients. However, two articles in this review stated that the combination of toothbrushing and suctioning did not significantly reduce the incidence of VAP. This may be due to other factors, such as the choice of mouthwash used. Furthermore, the choice of toothbrush and suction device may influence the effectiveness of the toothbrushing and suctioning methods. Therefore, the researchers suggest that further research is needed on this combination of oral hygiene methods.

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