

DENTAL AND ORAL CARE TO REDUCE THE INCIDENCE OF VENTILATOR ASSOCIATED PNEUMONIA AMONG PATIENTS WITH VENTILATOR IN INTENSIVE CARE UNIT: A SYSTEMATIC REVIEW

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ABSTRACT

Background: Patients in the intensive care unit (ICU) are at risk for dying not only from their critical illness but also from secondary processes such as nosocomial infection. Ventilator-associated pneumonia (VAP) is the second most common nosocomial infection in the ICU and the most common in mechanically ventilated patients. Oral and dental care may reduce microorganisms in the oral cavity. This study was aimed to review the effect of dental and oral care to reduce the incidence of ventilator-associated pneumonia among patients with ventilator in the intensive care unit.

Subjects and Method: A systematic review was conducted by searching published articles from 2014 to 2019, from PubMed. The inclusion criteria were articles in English, full text, randomized controlled trial, and open access. The dependent variable was the incidence of VAP. The independent variable was dental and oral care. After the review process, 8 articles were included in this review.

Results: Eight articles reported that dental and oral care is one of the key factors for VAP prevention. It is an effective procedure to decrease nosocomial infections, colonization of the bacteria, and a tendency to reduce the incidence of VAP.

Conclusion: Dental and oral care reduces the incidence VAP.

Keywords: ventilator associated pneumonia, oral care, intensive care unit

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BACKGROUND

Regulation of the Minister of Health of the Republic of Indonesia Number 27 of 2017 concerning Guidelines for Prevention and Control of Infections in Health Care Facilities states that the type of Healthcare-Associated Infections (HAI) most often occurs in Hospitals (RS) one of which is Ventilator Associated Pneumonia (VAP). Risk factors for triggers of HAI include the anatomical barrier interruption or form of ventilator use (Ministry of Health, 2017).

VAP is a nosocomial infection that occurs after 48 hours of use of

Mechanical Ventilation (VM) (Wu et al., 2019). Nosocomial infection is one of the main causes of mortality in critical patients in the Intensive Care Unit (ICU) (Vilela et al., 2015).

Infectious Diseases Society of America (IDSA) and the American Thoracic Society (ATS) report that the VAP mortality rate in America reaches 13%. Studies in Europe show that the VAP mortality rate in 30 days reached 29.9%, the initial VAP mortality rate was 19.2%, and the advanced stage VAP mortality was 31.4%. In mainland China, the incidence of VAP reached 23.8% in 2006-2014 (Wu et al., 2019).

Numerous studies show the prevalence of VAP in VM patients reaches 9-68% which causes mortality up to 30-70%. VAP causes longer ICU stay up to 6-7 days, medical costs increase by \$ 40,000 per patient, longer VM usage, and increased morbidity, mortality, and patient suffering (Atashi et al., 2018).

The mouth of a patient with VM can function as a reservoir for pathogenic pneumonia in the hospital. VAP prevention interventions are needed to prevent recurrent microaspiration, colonization of pathogenic organisms in the upper respiratory and gas-trointestinal tracts, and ventilator contamination.

Oral pathogen control procedures need to be considered for NP prevention. Many variations of oral care intervention methods in VM patients in the ICU. Basically, there are two ways to remove dental plaque and related microorganisms, namely through mechanical and/ or pharmacological intervention (Vilela et al., 2015).

A series of evidence-based treatments for the prevention of VAP in the ICU were created. PERMENKES No. 27 of 2017 issues seven series of VAP prevention and control, including (1) cleaning hands every time an patient is performed, (2) positioning the bed 30-45° if there are no contraindications, such as head and spinal cord injuries, (3) maintain oral hygiene every 2-4 hours with chlorhexidin (CHX) 0.02% and brush your teeth every 12 hours, (4) management of oropharyngeal and tracheal secretions, (5) assess the use of sedation and extubation every day, (6) administration of peptic ulcer disease prophylaxis in high-risk patients, and (7) administration of Deep Vein Th-

rombosis (DVT) prophylaxis (Ministry of Health, 2017).

SUBJECTS AND METHOD

a. Study Design

This study is a Systematic review that aims to look at the effects of dental and oral care on the reduced incidence of VAP in VM patients in the ICU. The article search was carried out systematically through a single database (PubMed) using several keywords stated below. The search involved the term "oral care" OR "dental care" OR "mouth care" OR "dental hygiene" AND "ventilator associated pneumonia" OR "vap" OR "ventilator \$ acquired pneumonia" OR "nosocomial pneumonia" OR "hospital acquired OR "hospital" associated pneumonia "OR" pneumonia "AND" ventilation "OR" ventilator "OR" mv "OR" mechanical ventilation "OR" intensive care unit "OR" ICU "pneumonia.

b. Inclusion and Exclusion Criteria

Articles must have the following inclusion criteria: (a) published in full-text form in peer-reviewed between 2014 and 2019. (b) use English, (c) performed on critical patients receiving MV in adult ICUs, (d) patients received dental and oral care either mechanically or pharmacologically while using MV, (f) age of the study population ≥ 16 years, (g) outcome measures: VAP incidence, and (h) Randomized Controlled Trial (RCT) study design.

c. Data Extraction

The search was conducted from 27 July to 25 August 2019 independently by one author. The titles and abstracts of all articles are identified to see the relevance of the systematic review topic. Duplicated, irrelevant, non-English,

and incomplete articles will be excluded from selection. The article is read thoroughly to verify the suitability of the inclusion criteria. Data is made into structured tables and analyzed and conclusions are made based on selected references. Data analysis was made descriptively, without meta-analysis. Data extraction was performed by one

writer which included information on the author's name, year, location, country, design or period, study population, inclusion and exclusion criteria, measures of success, control groups, intervention groups, and outcomes. Researchers adhere to the PRISMA guideline standard shown in Figure 1.

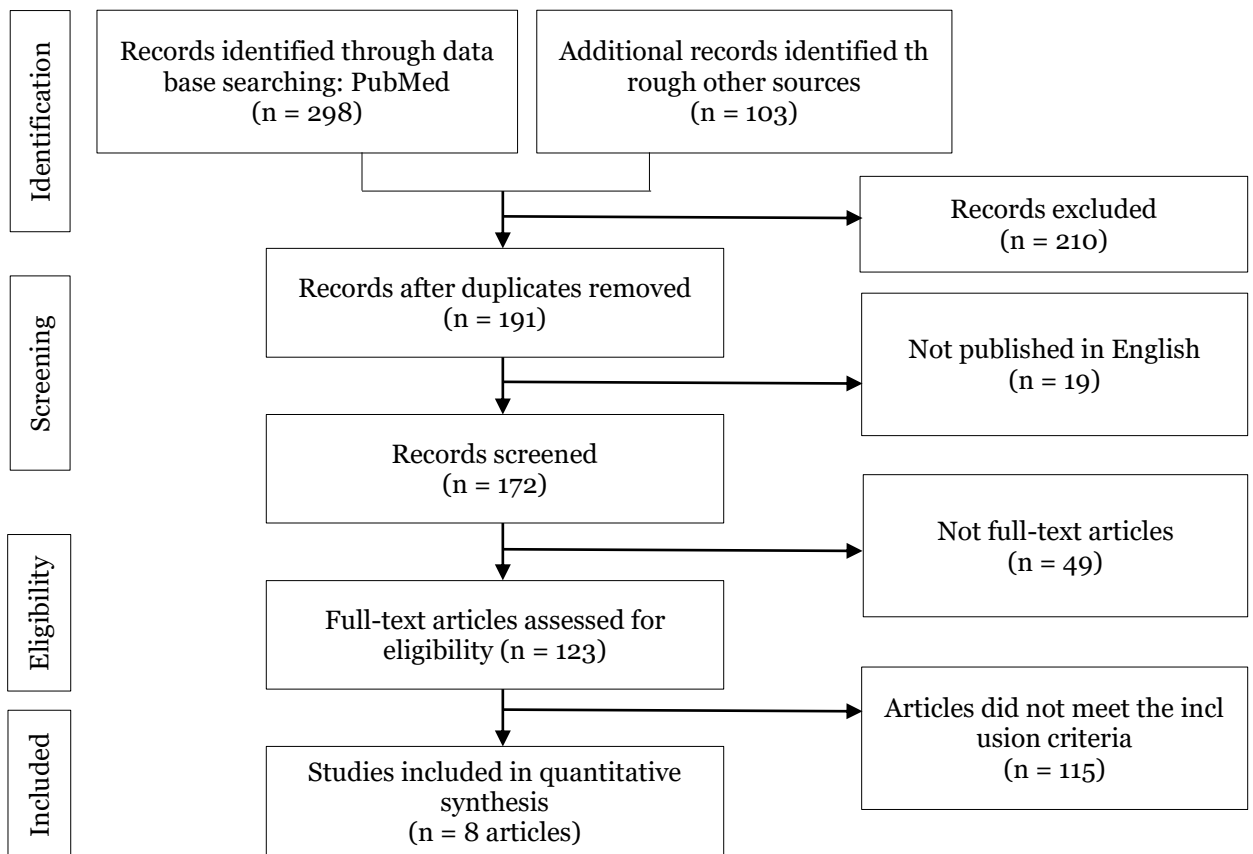


Figure 1. PRISMA systematic review identification, screening, eligibility, and inclusion

Table 1. Methodological characteristics of the article review

No	Title, Author, Year, Journal	Purpose	Sampel and Intervention	Results
1	Impact of oral hygiene involving toothbrushing versus CHX in prevention of ventilator-associated pneumonia: a randomized study / Claudia Fernanda de Lacerda Vidal, dkk / 2017 / BMC Infectious Diseases	To assess the impact of tooth brushing as a way of oral care on the incidence of VAP	<ul style="list-style-type: none"> • Location: 3 ICU public hospitals and 1 ICU philanthropic hospital, Recife, Brazil • Research period: July 2013-January 2014 • Participants: • Inclusion: Age 18 years or older, intubated and expected to continue to use melanis ventilation for > 48 hours, no lung infection at admission. • Exclusion: Patients without teeth, suspected pneumonia at the time of intubation, pregnancy, tracheotomy, and allergy to CHX. • Randomized number: 213 (108/105) • Control group: Oral cleaning is done every 12 hours through aspiration of oropharyngeal secretions. Application of 15 mL of 0.12% CHX gluconate solution using cotton on all surfaces of teeth, tongue and oral mucosa. The entire process is carried out by nursing staff and follows special standard operating procedures. • Intervention group: Oral cleaning is done every 12 hours through aspiration of oropharyngeal secretions. Brushing the teeth on all surfaces of the teeth, tongue, and mouth mucosa through the use of a toothbrush with a small and soft book, then the application of dental gel CHX gluconate 0.12%. Then rinsed and aspirated through a catheter combined with a toothbrush. The entire process is carried out by nursing staff and follows special standard operating procedures. 	<ul style="list-style-type: none"> • Brushing and CHX gel application of 0.12% reduced the incidence of VAP, but not significantly (p = 0.084) • The mean time for VM decreased significantly in the intervention group (p = 0.018) • The length of stay in ICU and mortality rates between the two groups were not significantly different (p = 0.064), but there was a tendency for reduced length of stay in the intervention group <p>Conclusion: In patients who had tooth brushing, the duration of VM use was significantly reduced and there was a tendency for reduced VAP events and length of stay in ICU (not statistically significant).</p>
2	Oral decontamination	Compare the incidence of VAP in	<ul style="list-style-type: none"> • Location: Tertiary care center in South India • Research period: January 14 2014 - 	<ul style="list-style-type: none"> • There was no significant difference between the two groups in the

<p>techniques and ventilator-associated pneumonia / Ranjitha Chacko / 2017 / British Journal of Nursing</p>	<p>ventilator patients who brush their teeth (with CHX and suction) compared to conventional / routine oral care (mouth swabs with CHX)</p>	<p>December 27, 2014</p> <ul style="list-style-type: none"> • Participants: • Inclusion: Patients who are ventilated through the orotracheal tube and intubated in 4-6 hours, aged 16 years and over, receive a series of VAP treatments (head-end elevation, antibiotics, H2 receptor blockers, oral care, hand hygiene, cleaning tools, and universal precautions). • Exclusion: Having a naso-tracheal tube or tracheotomy, diagnosed pneumonia on admission, VM installation outside the institution, the presence of dentures or few remaining teeth (less than 6 teeth), immunocompromised (absolute neutrophil less than 500), prescribed immunosuppressant drugs, thrombocytopenia (less than 50,000 / mm3), and the presence of ulcers in the mouth. • Randomized number: 212 (106/106) • Control group: Routine care with mouth cavity swabs with sponges soaked in CHX 0.2% • Intervention group: given an oral care kit with one toothbrush, a disposable Yankauer suction catheter, and a disposable syringe. 0.2% CHX is inserted into the oral cavity with the help of a syringe. Lidan and brushed teeth. The oral cavity was simultaneously sucked up with a Yankauer suction catheter. 	<p>incidence of VAP (p = 0.82).</p> <ul style="list-style-type: none"> • There is a relationship between gender (p = 0.01) and antibiotic administration (p = 0.01) on the development of VAP. • Other variables, such as age, comorbidities, type of antibiotic, antibiotic-days, and length of ICU stay were not related to the development of VAP. • There is a significant relationship between the days of ventilator use and the development of VAP. The risk of developing VAP increases by 1.3x each day of ventilation.
<p>3 Effect of Oral care Program on Prevention of Ventilator-associated Pneumonia in Intensive Care Unit Patients: A Randomized Controlled Trial / Vajihe</p>	<p>To determine the effect of an oral care program based on a specific frequency in VAP patients in the ICU</p>	<ul style="list-style-type: none"> • Location: ICU Hospital affiliated with Isfahan University of Medical Science, Iran • Research period: November 2016- August 2017 • Participants: • Inclusion: Age 18-65 years, endotracheal tube by mouth, hospitalization in ICU less than 24 hours, not hospitalized in other hospitals before ICU admission, no history of autoimmune disorders, 	<ul style="list-style-type: none"> • There were no significant differences between the two groups on the average CPIS (Clinical Pulmonary Infection Score) on the first, third, and fifth days (p> 0.05) • There were no significant differences between the two groups on the frequency of VAP on the third and fifth days (p>

Conclusion: Early removal of the ventilator can reduce the risk of VAP. Tooth brushing does not reduce the incidence of VAP compared to regular oral care. Oral hygiene is one of the key factors along with other interventions for the prevention of VAP.

<p>Atashi, dkk / 2018 / Iranian Journal of Nursing and Midwifery Research</p>	<p>pneumonia, or sepsis, non-pregnant, insensitive on herbs, there are no dentures, and no oral or perioral lesions.</p> <ul style="list-style-type: none"> • Exclusion: The patient died, was transferred from the ICU to another room, the development of severe oral lesions, and the patient's guardian chose to withdraw from the study. • Randomized number: 80 (40/40) • Control group: Routine care is given by positioning the bed 300-450. The use of swab and chlorhexidin 0.2% solution every 12 hours by nurses. • Intervention group: Oral care is carried out by two research assistants who have work experience at the ICU. Research assistants receive training needed for oral care from researchers. The intervention began on the first day of ICU admission and continued for 5 consecutive days. The intervention was carried out with endotracheal pressures between 20 and 25 mmHg using a special manometer: the position of the head of the bed 300-450; deep mouth and throat suctioning; brush the entire internal and external surfaces of the teeth, gums and tongue for two minutes using a baby toothbrush then using CHX 0.2%; moisturizing all mucous surfaces of the mouth, gums and tongue with swabs and moisturizing gels containing aloe vera and peppermint essential oils; thin application of petroleum jelly to the lips; remove and clear airway obstruction; and reinserting the tube into the patient's mouth. The frequency of treatment is determined every 12, 8, 6, and 4 hours for patients without, mild, moderate, and severe. 	<p>0.05), but the frequency of pneumonia in the intervention group decreased compared to the control group.</p>	
<p>4 The Impact of Oral Care On Oral Health</p>	<p>To see the impact of oral care on</p>	<ul style="list-style-type: none"> • Location: ICU Educational Hospital in Sari affiliated with Mazandaran 	<ul style="list-style-type: none"> • Oral health status: significant differences between the two groups

Conclusion: Oral care programs did not significantly reduce the incidence of VAP in critically ill patients compared to routine oral care practices. It is necessary to make a study with a larger sample and a longer duration for better results.

<p>Status And Prevention of Ventilator-Associated Pneumonia In Critically Ill Patients / Abdullah Haghghi, dkk / 2016 / Australian Critical Care</p>	<p>oral health status and the incidence of VAP in ICU patients</p>	<p>University of Medical Sciences, Iran.</p> <ul style="list-style-type: none"> • Research period: October 2015- February 2016 • Participants: • Inclusion: Intubated during the study period, ages 18-65 years, less than 12 hours ICU length of stay, no reintubation, no severe facial and mouth trauma, no chronic diseases, no immune disorders, no natural teeth, does not have lung disease or pneumonia or sepsis • Exclusion: The patient died, was transferred from the ICU, received a VM in less than 48 hours, and was allergic to CHX. • Randomized number: 124 (62/62) • Control group: Brushing your teeth with toothpaste once a day and cleaning the mouth using 0.2% CHX fluid twice a day by a nurse • Intervention group: Brushing the internal and external surfaces of the gums with children's toothbrush and rotating movements from top to bottom. Rinse with 0.9% saline solution, suctioning is done for 30 seconds. Spray 5cc CHX 0.2% using a syringe on teeth, tongue, gums and mucosa followed by suctioning of the mouth and throat after 30 seconds. Dampen lips and mouth with vitamins A & D. Guedel airway removed, cleaned, re-paired if relevant. 	<p>occurred on the third day (p <0.001)</p> <ul style="list-style-type: none"> • Mucosal-plaque index: significant differences between the two groups occurred on the fifth day (p <0.001) • The incidence of pneumonia on the third and fifth days was no significant difference between the two groups (p = 0.538), but the incidence of the intervention group was reduced compared to the control group <p>Conclusion: A systematic oral care program did not significantly reduce the incidence of VAP in critically ill patients compared to conventional oral care, but was significant in improving oral health and the mucosal-plaque index.</p>
<p>5 The Effect of Oral Rinse With 0.2% And 2% CHX On Oropharyngeal Colonization And Ventilator Associated Pneumonia In Adults' Intensive Care Units / Farid</p>	<p>To design and implement oral care protocols and compare the effects of two different CHX concentrations on reducing</p>	<ul style="list-style-type: none"> • Location: ICU Nemazee Hospital and Shahid Rajaei, Shiraz University of Medical Sciences, Shiraz, Iran • Research Period: - • Participants: • Inclusion: Patients aged 18 years or older, have a tracheal tube, use the VM for 48 hours, have not been diagnosed with pneumonia at admission, have no history of CHX allergies, do not suffer from mucosal inflammation or trauma in the oral cavity, have no immune 	<ul style="list-style-type: none"> • In the 2% CHX solution group there was a significant reduction in VAP (p = 0.007) and oropharyngeal colonization (p = 0.007) compared to the CHX 0.2% group • There was no significant difference between the two groups on the oropharyngeal adverse effect (p = 0.361)

	Zand, dkk / 2017 / Journal of Critical Care	oropharyngeal colonization and VAP in ICU patients	<p>disorders, are not experiencing burns, is not pregnant, and is treated in the ICU for the first time. Patients treated for trauma, surgery, neurological problems, medical or neurosurgery.</p> <ul style="list-style-type: none"> • Exclusion: Patients have obvious aspiration, diagnosed with thrombocytopenia and possible bleeding due to oral care (platelets <40,000/mm³). • Randomized number: 114 (57/57) • Both groups performed the same steps and were only distinguished from CHX concentrations (CHX 0.2% and CHX 2%) 	<p>Conclusion: Oral decontamination with CHX 2% is more effective in preventing VAP and reduced oropharyngeal colonization (especially gram-positive) compared with CHX 0.2%</p>
6	Prospective, Randomised, Controlled Study Evaluating Early Modification of Oral Microbiota Following Admission To The Intensive Care Unit And Oral Hygiene With CHX / Felipe Francisco Tuon / 2017 / Journal of Global Antimicrobial Resistance	To evaluate the incidence of pathogenic bacteria related to VAP and the scope of dental plaque in the oral cavity in patients given CHX	<ul style="list-style-type: none"> • Location: University Hospital in Curitiba, Brazil • Research period: June 2014 - March 2015 • Participants: • Inclusion: When admission is accompanied by VM installation, age 18 or older, has a probability of using VMs > 48 hours, and permanent teeth (anterior and posterior) • Exclusion: Failure to give written consent, hospitalization > 24 hours, recent use of antibiotics (<1 week), admission to another hospital or emergency room in the near future, and suspected infection in the upper or lower respiratory tract. • Randomized number: 16 (8/8) • Control / Placebo group: Patients are cleansed with 0.9% NaCl solution • Intervention group: Patients are cleansed with a 2 ML CHX solution mixed with 15 ML by the nursing team. The CHX solution is gently brushed to the gums, mucosa, and tongue twice a day until it exits the ICU 	<p>When ammunition, multi-drug resistant (MDR) bacteria are reported, including carbapenem-resistant <i>Klebsiella pneumoniae</i>.</p> <ul style="list-style-type: none"> • The intervention group had a lower incidence of methicillin-resistant <i>Staphylococcus aureus</i> (MRSA) compared to the control group (p = 0.011). • Strains showed low MICs (Minimum Inhibitor Concentrations) and MBCs (Minimum Bactericidal Concentrations) in the intervention group (<0.039mg / mL) <p>Conclusion: MDR bacteria quickly colonized dental plaque and CHX were able to reduce the incidence of <i>S. aureus</i> colonization.</p>
7	Evaluating The Efficacy of Nanosil Mouthwash On The	To investigate the preventive effects of	<ul style="list-style-type: none"> • Location: ICU Amin Hospital, Isfahan University of Medical Sciences, Iran • Research period: November 2016 - May 2017 	<ul style="list-style-type: none"> • In both groups, the mean scores of SOFA (Sequential Organ Failure Assessment) and GCS (Glasgow Coma Scale)

Preventing Pulmonary Infection In Intensive Care Unit: A Randomized Clinical Trial / Bahareh Khaky, dkk / 2018 / Med Arch	the oral decontamination program by Nanosil mouthwash on the incidence of VAP	<ul style="list-style-type: none"> • Participants: • Inclusion: Age 18-70 years, no trauma to the jaw and face making it difficult for oral care, having a tracheal tube, using VM, no pneumonia at hospital admission (MCPIS <7) up to 48 hours after intubation, and no refusal to use Nanosil or CHX allergy. • Randomized number: 80 (40/40) • Control group: Application of CHX 0.12% as much as 15 mL 3x a day, followed by brushing teeth, suctioning oral secretion, and scrubbing the oropharyngeal mucosa. The method is the same as the intervention group • Intervention group: Application of 15 mL 3 times daily Nanosil (hydrogen peroxide and few silver ions), followed by brushing teeth, oral suctioning secretion, and scrubbing the oropharyngeal mucosa. The method is the same as the control group • Both groups ran a five-day oral decontamination program 	<p>increased significantly on the fifth day ($p < 0.05$)</p> <ul style="list-style-type: none"> • After five days, the mean MCPIS score ($p < 0.001$) and pneumonia level ($p = 0.008$) were significantly lower in the intervention group. • Mortality rates in both groups are the same ($p > 0.05$)
8 Effect of Oropharyngeal Povidone-Iodine Preventive Oral Care on Ventilator-Associated Pneumonia IN Severely Brain-Injured Or Cerebral Hemorrhage Patients: A Multicenter, Randomized Controlled Trial / Philippe Seguin, dkk / 2014 / Critical Care Medicine Journal	To evaluate the efficacy and safety of oral care with povidone iodine against the incidence of VAP in high-risk populations	<ul style="list-style-type: none"> • Location: Six hospitals ICU in France • Research period: May 2008 - May 2011 • Participants: • Inclusion: All patients over 18 years with closed traumatic brain injury with GCS ≤ 8 and VM are expected to continue to use ≥ 48 hours • Exclusion: Oral treatment procedures cannot be performed within 12 hours after endotracheal intubation and / or have tetraplegia, facial trauma, pulmonary contractions involving more than one lobe, aspiration pneumonia, current curative antimicrobial therapy, allergic to povidone iodine, and pregnant • Randomized number: 179 (88/91) • Control group: A placebo that is identical in color, odor and texture to povidone iodine. 20 mL placebo 	<ul style="list-style-type: none"> • There was no significant difference between the two groups on the incidence of VAP ($p = 0.69$) • There was no significant difference between the two groups with ventilator-associated tracheobronchitis ($p = 0.47$) • Acute respiratory distress syndrome occurred in 5 patients in the intervention group, but did not occur in the control group ($p = 0.06$) • There was no difference between the two groups on ICU length of stay ($p = 0.82$) and RS ($p = 0.35$), and ICU mortality ($p = 0.30$)

Conclusion: Nanosil is more effective than CHX to prevent VAP and reduce the incidence of VAP in critical patients in the ICU.

was diluted with 40 mL of sterile water using a 60 mL syringe. The solution is injected into the buccal region and pharyngeal cavity and suctioned for 2 minutes regularly every 4 hours. The protocol continues until extubation or until the 30th day

- Intervention group: 20 mL of 10% povidone iodine diluted with 40 mL of sterile water using a 60 mL syringe (final concentration of 3.3%). The solution is injected into the buccal region and pharyngeal cavity and suctioned for 2 minutes regularly every 4 hours. The protocol continued until extubation or until the 30th day before recruitment, participating nurses were trained in how to perform oral procedures.
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Conclusion: Povidone iodine is not effective in preventing VAP in cases of brain injury or cerebral hemorrhage and can increase the incidence of acute respiratory distress syndrome. Not recommended for use to prevent VAP in high-risk patients

RESULTS

Of the initial 401 articles, 8 articles met the criteria set out by systematic review (table 1). Research studies are carried out in several countries. The article consists of two types of research groups, namely the control group and the intervention group.

All articles mention that the reduction in the incidence of VAP cannot be done only with dental and oral care. Most articles show that dental and oral care interventions can reduce bacterial colonization in the oral cavity. All articles show dental and oral care does not reduce the length of stay in the ICU and mortality rates. One article shows the longer the time to use a VM, the greater the risk of VAP.

Two articles show that the combination of two kinds (mechanical and pharmacological) dental and oral care methods have insignificantly different results compared to using only one method (only CHX pharma-

cological applications) to reduce the incidence of VAP. The 2% CHX concentration is more effective in reducing microbial colonization compared to CHX 0.2%. Nanosil solution (hydrogen peroxide and few silver ions) has better ability to prevent VAP compared to CHX. The use of povidone iodine solution is not effective in preventing VAP in cases of brain injury or cerebral hemorrhage, but can cause acute respiratory distress syndrome.

DISCUSSION

The European Respiratory Society (ERS), the European Society of Intensive Care Medicine (ESICM), the European Society of Clinical Microbiology and Infectious Diseases (ESCMID) and Asociación Latinoamericana del Tórax (TOOL) issued a management guide for Hospital-Acquired Pneumonia (HAP) and VAP. The guidelines discuss the need for oral and oropharyngeal decontamination. (Torres, et al., 2017).

RI Minister of Health Regulation No. 27 of 2017 concerning Guidelines for Prevention and Control of Infections in Health Care Facilities also issues seven series of VAP prevention and control, where one indicator is controlling oral hygiene every 2-4 hours by using CHX 0.02% antiseptic and teeth brushing every 12 hours once (Ministry of Health, 2017).

VAP is the most common nosocomial infection in VM patients. Microaspiration and biofilm formation in Endotracheal Tube (ET) are the main causes of microbial colonization in the airways that can lead to the development of VAP. Oral biofilms and ET play an important role in the development of pulmonary infections, resistance to treatment, and recurrence of infection in VM patients (Diaconu, et al., 2018). Microorganisms in the oral cavity can move to lower airways during VM use leading to the occurrence of VAP (Sands, et al., 2016).

Control of biofilm formation in ET and oropharyngeal cavities is needed as a VAP prevention strategy. The need to decontaminate is important because some studies show that 48 hours after admission, oropharyngeal colonization by gram-negative bacilli will form an NP etiological agent (Vilela et al., 2015).

Oral decontamination methods are very diverse, the application of CHX is the first choice in the decontamination process in VM patients in the ICU. CHX is a broad-spectrum cationic antiseptic agent including gram-positive and gram-negative bacteria, such as *S. aureus* which are resistant to oxacillin and *Enterococcus* sp. which is resistant to vancomycin. Chemically CHX active-

ly works for up to 6 hours (Vilela et al., 2015). CHX application is proven to reduce microbial colonization (Tuon, et al., 2017; Zand, et al., 2017), but it is not statistically significant to reduce the incidence of VAP. CHX concentrations for application also vary from 0.12%, 0.2%, and 2% (Vilela et al., 2015). CHX concentration of 2% was proven effective in reducing microbial colonization compared to CHX 0.2% (Zand, et al., 2017) while CHX 0.2% was more effective for the prevention of VAP. CHX application twice a day is effective enough to reduce microbial colonization and prevent VAP (Guler & Turk, 2019).

The combination of two methods (toothbrush and CHX application) is no better in reducing the incidence of VAP than one method (CHX application) (Vidal, et al., 2017). Oral hygiene of patients does not differ greatly between the oral swab or toothbrush method, but nurses state that the toothbrush protocol is easier to apply (Ory, 2017). The tooth brushing method alone does not reduce the incidence of VAP (Camargo, et al., 2019).

The meta-analysis was not carried out due to too varied methodologies, heterogeneity of patient populations, results and assessment methods. The possibility of bias by ICU nurses when applying treatment methods and the least number of study populations. Based on the terms of the systematic review, additional studies are needed to reach more definitive conclusions on the most effective dental and oral care methods, the best frequency of treatment, and optimal concentration of CHX use.

In conclusion, dental and oral care can reduce biofilm colonization in the oral cavity. Biofilms in the controlled oral cavity tend to reduce the incidence of VAP. The use of CHX becomes the golden standard in an effort to maintain oral hygiene. Dental and oral care is one of a series of effective programs for the prevention of VAP in VM patients. The series of VAP prevention programs are expected to be able to encourage the development of a patient safety culture in hospital ICUs.

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