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Original Research Article

Conventional and comprehensive oral hygiene procedures using Chlorhexidine 0.2% in patients with mechanical ventilator

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ABSTRACT

Background: Ventilator-Associated Pneumonia (VAP) in the intensive care unit patients is related to the oropharyngeal bacteria colonization. The purpose of this study was to compare the number of oropharyngeal bacterial colonies after conventional and comprehensive oral hygiene procedures in patients with mechanical ventilators.
Methods: This study uses an experimental design on 32 subjects with mechanical ventilators. Conventional group/K group (n=16) used 0.2% chlorhexidine gluconate antiseptic conventionally using a sterile gauze while the comprehensive group/L group (n=16) used 0.2% chlorhexidine gluconate antiseptic comprehensively using a toothbrush every 12 hours. Bacterial Isolation is done using swab technique. The number of bacterial colonies and bacterial identification before and after oral hygiene procedure was examined. The data were statistically analyzed using the Wilcoxon test and the Mann Whitney test using SPSS 19.0 software.
Results: There was a significant decrease in the number of oropharyngeal bacterial colonies before and after oral hygiene both in the conventional group (p=0.002) and comprehensive group (p=0.002). However, there was no significant difference between the number of bacterial colonies in the two groups before (p=0.269) and after the oral hygiene procedure (p=0.295). The most common bacterium in the conventional and comprehensive group are *Enterobacter gergoviae* and *Escherichia coli*, respectively. *Klebsiella pneumonia* have decreased the most after conventional oral hygiene while *Pseudomonas aeruginosa* has decreased the most after comprehensive oral hygiene.
Conclusions: Conventional and comprehensive oral hygiene significantly reduces the number of oropharyngeal bacterial colonies. Both techniques can be used as oral hygiene techniques with relatively similar results.

Keywords: Intensive care unit, Mechanical ventilators, Oral hygiene, Oropharyngeal bacteria

INTRODUCTION

A mechanical ventilator helps the respiratory function of patients with hypoxemia, severe hypercapnia, and respiratory failure. A mechanical ventilator is important and widely used for a critical patient in the Intensive Care Unit (ICU), with the usage is reaching 1.5 million per year in the United States. A mechanical ventilator is one of the important aspects and is widely used for critical patient care in the Intensive Care Unit (ICU), with the usage is reaching 1.5 million per year in the United States.[1]

The ICU patients potentially developing nosocomial Ventilator-Associated Pneumonia (VAP) infections. The VAP is associated with inappropriate use and maintenance of mechanical ventilators which causes bacterial colonization in the oropharynx.[2] Chen et al, showed that VAP is the second-highest Device Associated Infection (DAI) incidence in the intensive care unit of Taiwan.[3] From these studies, the VAP incidence rate was 3.18 of 1000 ventilators use. The VAP prolongs the length of hospitalization and is closely related to the high morbidity and mortality of patients in the ICU which the mortality rates reaching 40-50%. The VAP generally occurs after 48 hours post-mechanical ventilation installation, both through the endotracheal tube and tracheostomy tube. The VAP is a major concern in the ICU because it is difficult to diagnose accurately and requires high medical costs.[4,5]

Some factors can trigger VAP including: age over 60 years, severity of disease, acute or chronic lung disease, excessive sedation, enteral nutrition, severe burns, supine body position, Glasgow Coma Scale (GCS) less than 9, the use of muscle relaxants, smokers, bacterial colonization of potentially pathogenic oropharynx and the duration of ventilator use.[1,6,7] One of the most influential risk factors for pneumonia is the colonization of pathogenic bacteria in the oropharynx such as *Staphylococcus aureus*, *Streptococcus pneumonia*, or gram-negative rod-shaped bacteria. Dental plaque also is a habitat for microorganisms such as Methicillin-Resistant *Staphylococcus Aureus* (MRSA) and *Pseudomonas aeruginosa* which are responsible for the incidence of ventilator-related pneumonia.[7,8] The use of mechanical ventilators with tubes intubated into the patient's body will facilitate bacterial entry and cause endotracheal tube contamination in patients with a supine position.[9]

Oral hygiene with antibiotics or antiseptics is a procedure used to reduce oropharyngeal bacteria colonization and prevent VAP by cleaning and refreshing the mouth, teeth, and gums. The use of antiseptic chlorhexidine gluconate 0.2% is recommended in the oral hygiene of patients with mechanical ventilators.[7,10,11] In the XXX: Dr. Saiful Anwar General Hospital intensive care unit, the use of 0.2% chlorhexidine gluconate as an antiseptic agent for oral hygiene is used by applying sterile gauze to the entire surface of the teeth, tongue, and mouth (conventional technique). Recent studies have shown that using 0.2% chlorhexidine gluconate can be more effective using comprehensive techniques (using a soft toothbrush).[7] The study want to compare the number of orafaring bacteria after oral hygiene procedure using chlorhexidine 0.2% with conventional and comprehensive techniques in patients with mechanical ventilators.

METHODS

This study is a true experiment on 32 subjects with mechanical ventilators in the Intensive Care Unit of XXX: Dr. Saiful Anwar General Hospital. The study was held in the Intensive Care Unit of xxx, between September 2018-April 2019. All research subjects provided written informed consent to be included in the study.

Inclusion criteria

- Patients using a ventilator without VAP, did not experience contradictions when receive oral hygiene chlorhexidine gluconate 0.2%, age 17-65 years, and BMI 18.5-25 kg/m^2.

Exclusion criteria

- Patients having immune system disorders, diabetes, suffering from pneumonia before entering ICU, burns, patients with broad-spectrum antibiotics for more than 12 hours, patients in infectious conditions, allergic to antiseptics and patients experiencing oral bleeding/coagulopathy.

The study method was approved by the Health Research Ethical Committee of xxx (No: 400/178 / K.3 / 302/2018). The research subjects were divided into two groups. Group K received conventional oral hygiene procedures (n=16) and group L received comprehensive oral hygiene procedures (n=16). In group K, subjects were placed with oblique head position. A pad placed under the chest to the chin and then bent under the cheeks. Water is sprayed into the oral cavity, then suction is placed under the tongue. The spattel is taken with the left hand to press the dorsum of the tongue until the mouth is open. Chlorhexidine gluconate 0.2% 15 ml is given in the teeth, gums, mouth, and tongue using sterile gauze. In group L, the four quadrants of teeth brush using toothbrushes and the water was sprayed between the quadrants in a regular pattern. Saliva and the remaining water are sucked using a suction catheter and tongue spattle to press the tongue. Then the water is sprayed back into the oral cavity and sucked again. Chlorhexidine gluconate 0.2% 15 ml is given in the teeth, gums, mouth, and tongue using gauze.

Bacterial isolation was done by swab technique before (Swab I) and after oral hygiene (Swab II). Swab II is taken 12 hours after oral hygiene. Samples were cultured in Nutrient Agar media at 37°C for 24 hours. Biochemical tests, sensitivity tests, and microscopic tests are done to identified bacteria classification.

Statistical analysis

The data were analyzed using the Wilcoxon test and the Mann Whitney test using SPSS 19.0 software.

RESULTS

This study was a true experiment on 32 subjects. The characteristics of the study subjects can be seen in (Table 1). The mean age of the subjects was 38.00±13.95 years in group K and was 42.00±15.55 years in group L.

The mean body weight of group K was 65.13±6.67 kg and 63.06±9.34 kg in group L. The mean height of the subjects was 164.94±2.86 cm in the K group and was 158.06±24.60 cm in the L group. The mean BMI in group K was 24.00±1.88 (kg/m^2) and was 23.55±2.32 (kg/m^2) in group L. Based on statistical tests, all sample characteristics are normally distributed and homogeneous.

Table 1: Characteristic of the subjects.

Characteristic	Conventional/ K group (n=16)	Comprehensive/ L group (n=16)	p-value
Age (mean±SD)	38.00±13. 95	42.00±15.55	0.450
Gender			
Male (%)	8 (50.0)	9 (56.3)	0.723
Female (%)	8 (50.0)	7 (43.8)	
Weight(kg)	65.13±6.67	63.06±9.34	0.478
Height(cm)	164.94±2.86	158.06±24.60	0.621
BMI(kg/m^2)	24.00±1.88	23.55±2.32	0.548

The number of oropharyngeal bacterial colonies was carried out before and after the oral hygiene procedure. In conventional oral hygiene, there is a significant difference between the number of bacterial colonies before and after the oral hygiene procedure. Before oral hygiene, the number of bacterial colonies was 2044.8±432.64 CFU/plates. After oral hygiene, the number of bacterial colonies significantly decreased to 1606.1±656.58 CFU/plate (p=0.002). There are six plates from each time observation declare to be Too Numerous To Count (TNTC) (Table 2).

In comprehensive techniques, there is also a significant difference between the number of colonies of oropharyngeal bacteria before and after oral hygiene procedures. Before oral hygiene, the number of bacterial colonies was 2218.08±263.23 CFU/plate. After oral hygiene, the number of bacterial colonies significantly decrease to 1777.77±367.79 CFU/plate (p=0.002). In the comprehensive technique, there are 3 sample plates declared as TNTC (Table 3).

There is no significant difference in the number of bacterial colonies in the conventional and the comprehensive group. Before the oral hygiene procedure, the number of bacterial colonies in the conventional and comprehensive group was 2044.8±432.64 CFU/ plate and 2218.08±263.23 CFU/ plate (p=0.269) respectively. Meanwhile, the number of bacterial colonies after oral hygiene in the conventional and comprehensive techniques group was 1606.1±656.58 CFU/plate and 1777.77±367.79 CFU/plate (p=0.295) (Figure 1).

Bacterial identification is carried out before and after the oral hygiene procedure. In conventional techniques, the most common bacteria found is *Enterobacter gergoviae*, while *Escherichia coli* is the most common bacteria in the comprehensive technique. Other bacteria including *Acinetobacter baumannii*, *Candida albicans*, *Klebsiella pneumonia*, *Enterobacter cloacae*, and *Enterobacter gergoviae* are found in the conventional group. *Klebsiella pneumoniae* experienced the greatest decrease from 1301.50 CFU/plate to 726.00 CFU/plate.

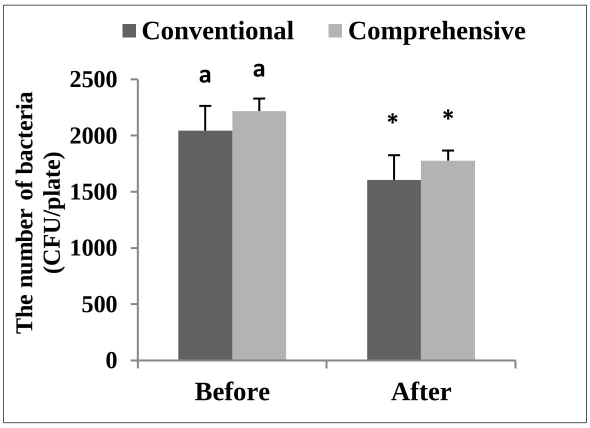

Figure 1: The number of bacteria colonies before and after oral hygiene procedure.

Acinetobacter baumannii, *Klebsiella oxitoca*, *Staphylococcus aureus*, *Candida albicans*, and *Escherichia coli* found in the comprehensive group.

Table 2: The number of bacteria before and after oral hygiene using conventional technique.

The number of bacteria	Conventional technique		p-value*
	Before oral hygiene	After oral hygiene	
	Mean±SD	Mean±SD	
Quantitative (CFU / plate)	2044.8±432.64(n=10)	1606.1±656.58(n=10)	0.002
TNTC	6 (37.5%)	6 (37.5%)	

CFU: Colony Forming Unit; TNTC: Too Numerous to Count; *Wilcoxon test

Table 3: The number of bacteria before and after oral hygiene using comprehensive technique.

The number of bacteria	Comprehensive technique		p value*
	Before oral hygiene	After oral hygiene	
	Mean±SD	Mean±SD	
Quantitative (CFU/plate)	2218.08±263.23 (n=13)	1777.77±367.79 (n=13)	0.002
TNTC	3 (18.8%)	3 (18.8%)	

CFU: Colony Forming Unit; TNTC: Too Numerous to Count *Wilcoxon test

Table 4: Bacterial colonies before and after oral hygiene procedures.

Bacteria	Conventional/ K group		Comprehensive/ L group	
	Before (CFU/plate)	After (CFU/plate)	Before (CFU/plate)	After (CFU/plate)
Enterobacter gergoviae	2378.00	2255.33	-	-
Pseudomonas aeruginosa	2290.33	1843.00	2308.33	1811.50
Klebsiella pneumoniae	1301.50	726.00	-	-
Candida albicans	1869.00	1564.00	TNTC	TNTC
Acinetobacter baumannii	1971.00	750.00	2030.67	1564.00
Enterobacter clocoae	TNTC	TNTC	-	-
Staphylococcus aureus	-	-	2103.67	1724.00
Escherichia coli	-	-	2582.00	2378.00
Klebsiella oxitoca	-	-	TNTC	TNTC

TNTC: Too Numerous to Count

In the comprehensive group, *Pseudomonas aeruginosa* experienced the greatest decreased from 2308.33 CFU/plate to 1811.50 CFU/plate. Generally, all bacteria colonies experience a decrease after oral hygiene procedures (Table 4).

DISCUSSION

This research was conducted to compare the number of oropharyngeal bacteria after oral hygiene procedure between conventional techniques and comprehensive techniques in patients with mechanical ventilators. Contaminated oropharyngeal secretions play an important role in the VAP formation.[12] The endotracheal tube potentially causes tracheal tissue damage due to extreme pressure from the pump, causing long-term damage. Endotracheal tubes also can be the bacterium's habitat to form and develop biofilms. Endotracheal tube installation also may disturb the natural protection or clearance mechanism of mucosal tissue. The endotracheal tube passes through the normal nasal filtration which functions to warm and humidify the air. The endotracheal tube passes through the normal nasal filtration which functions to warm and humidify the air. The lost of nasal filtration function to warm the air decreases the moisture of inhaled air and causes thickened mucus or difficult mucus mobilization. These things promote lung tissue injury and infection.[13,14]

The installed endotracheal tube also interferes with the mucociliary clearance mechanism. The endotracheal tube can be a direct channel for the pathogen to enters the lungs. Normal mucosal clearance through a mucociliary escalator is blocked and disrupted by the endotracheal tube cuff by forcing the epiglottis in the open position. The mucosal tissue secret will accumulate above the cuff, carried to the back of the throat and contaminate the subglottic pool. By leaving the epiglottis open, secret can travel to the trachea through the glottis between the vocal cords. The secret will be coming out from the endotracheal tube cuff and aspirate in the lungs. The endotracheal tube blocks the cough reflex and the positive pressure from the ventilator. With this contamination, pathogen multiplication and aspiration continue, so that pathogenic microorganisms are superior to the body antibacterial defenses.[15,16]

The effectiveness of antiseptic solutions is important to prevent infection. Chlorhexidine is a bisbiguanid antiseptic and disinfectant which has a variety of activities against gram-positive microorganisms, including multi resistant bacterial pathogens such as Methicillin-Resistant *Staphylococcus Aureus* (MRSA), Vancomycin-Resistant Enterococcus (VRE) and has a limited effect on gram-negative bacteria, fungi, and viruses. The chlorhexidine compounds efficiently change the permeability of bacterial cell walls, and rapidly precipitate components of cell membranes and cytoplasm.[17,18]

If the intubated patient does not get effective oral hygiene, dental plaque and hardened bacterial deposits will appear on the teeth for 72 hours. The condition will worsen by the appearance of gingivitis, gum inflammation, infection and microbial shifting from

Streptococcus and *Actinomyces spp* to basil aerobic gram-negative bacteria. An oral cavity is a suitable place for bacterial proliferation. Bacteria that attach to the tooth surface will slowly form biofilms and lead to the formation of dental plaque.[19,20]

The number of bacteria before and after comprehensive oral hygiene showed a significant difference (p=0.002). The number of bacterial colonies decreases from 2218.08±263.23 CFU/plate to 1777.77±367.79 CFU/plate. The decrease of bacterial colonies was associated with a decrease in VAP. Mori et al, study about VAP reduction after a comprehensive oral hygiene procedure.[21] Mori et al, used a toothbrush and rinsed it with povidone-iodine three times a day. The results show a decrease in the incidence of VAP in groups using comprehensive techniques. The result also supported by Sona et al, comparing VAP incidence before and after comprehensive oral hygiene.[22] This study compares the VAP incidence in all patients who used mechanical ventilation during pre and post-oral hygiene. The oral hygiene procedure is done by brushing teeth for 1-2 minutes at 12-hour intervals with 0.7% sodium mono-fluorophosphate. VAP incidence significantly decreases after oral hygiene. Comprehensive oral hygiene is considered important in pneumonia prevention. Routine oral decontamination can reduce VAP by 60%.[20,23]

Conventional oral hygiene techniques significantly reduce the number of bacteria from 2044.8±432.64 CFU/plate to 1606.1±656.58 CFU/plate (p=0.002). Klompas et al, showed there was a significant decrease in VAP incidence in patients with a ventilator after receiving oral hygiene using chlorhexidine.[24] Conventional and comprehensive oral hygiene capable reduce the number of bacteria. When comparing both groups, the number of bacteria before and after oral hygiene did not show a significant difference. The weaknesses of this study are the less specific bacterial identification and counting in certain bacteria. In conclusion, conventional and comprehensive oral hygiene significantly reduces the number of oropharyngeal bacterial colonies. Both techniques can be used as oral hygiene procedures with relatively similar results.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Health Research Ethical Committee of Dr. Saiful Anwar General Hospital (No: 400/178 / K.3 / 302/2018).

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