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The Effectiveness of Chlorhexidine 0.2% Mouthwash vs. Chlorhexidine 0.2% Mouthwash and Toothbrush in Preventing Ventilator Associated Pneumonia a Randomized Controlled Trial

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

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Original Research Article

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ABSTRACT

Background: Intensive care unit patients are fragile and highly susceptible to infections. Respiratory infections, especially ventilator-associated pneumonia, are the most frequent infectious complications in critically ill patients. Evidence-based patient care treatment practices have been developed by the Center for Disease Control and Prevention to decrease ventilator-associated pneumonia cases. Sixty percent of cases of ventilator-associated pneumonia have been reduced by simple oral routine care.

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Aims: To compare the effectiveness of 0.2% chlorhexidine mouthwash solution and chlorhexidine mouth wash with tooth brush and their association in demographic variables in patient admitted in critical care unit.
Methodology: A RCT was conducted from November 2020 to February 2021 in the patient under mechanical ventilation. Ethical clearance and written consent were obtained before collecting information. 30 participants in each control and experimental group were selected by applying the convenient sample technique method. Data was collected using the self-created Performa and the main tool, the Clinical Pulmonary Infection Score, to detect ventilator-associated pneumonia.
Analysis: The data gathered were analyzed and interpreted according to the objective of the study using SPSS version 20. Descriptive statistics were used to find out the demographic result, and the non-parametric Chi-square test was used to compare the data.
Results: Out of 60 participants, majority of patient belongs to 51-60 years, i.e. 11 (36.67%) in control group and 61-70 years, i.e. 13 (43.33%) experimental group. Patients who received chlorhexidine with tooth brushing intervention had higher Clinical pulmonary Infection Score values and higher rate of Ventilator Associated Pneumonia occurrence in experimental group 3(10%) than in control group 1(3.33%).
Conclusion: Combining tooth brushing with 0.2% chlorhexidine did not provide additional benefits over 0.2% chlorhexidine alone. There is no significant reduction in the rate of ventilator-associated pneumonia by applying 0.2% chlorhexidine with toothbrushing.

Keywords: Chlorhexidine; ventilator associated pneumonia; mechanical ventilation; toothbrushing.

ABBREVIATIONS

VAP : Ventilated Associated Pneumonia
ICU : Intensive Care Unit
ICCU : Intensive Critical Care Unit
MICU : Medical Intensive Care Unit
SICU : Surgical Intensive Care Unit
KLES : Karnataka Lingayat Education Society.
MV : Mechanical Ventilation
CPIS : Clinical Pulmonary Infection Score
NNIS : National Nosocomial Infections Surveillance
CDC : Centres For Disease Control And Prevention
RCT : Randomized Control Trials
SPSS : Statistical Package For Social Sciences
ET : Endo Tracheal Tube
D.F : Degree Of Freedom
F : Frequency
P : Probability Value

1. INTRODUCTION

Intensive care unit (ICU) patients are fragile and highly susceptible to infections. Respiratory infections, especially ventilator-associated pneumonia (VAP), are the most frequent infectious complications in critically ill patients. The use of ventilators for more than 48 hours may result in ventilator associated pneumonia which is a serious potential complication in the intensive care unit. Globally, 86% of nosocomial pneumonias are associated with mechanical ventilation. The National Nosocomial Infections Surveillance system (NNIS) of the US study shows that the second most common nosocomial infection in intensive care units is nosocomial pneumonia. The incidence of VAP ranges from 13 to 51 per 1000 ventilator days. VAP increases the rate of death, rate of illness, hospital, and ICU stay, and by this increasing healthcare cost, making it to be a serious medical condition, with attributable risk for mortality of 33–50%. In the USA alone, there are between 250,000 and 300,000 cases per year, at an incidence rate of 5–10 per 1000 admissions [1].

The International Nosocomial Infection Control Consortium (INICC) has done studies on nosocomial infection in 8 countries for 4 years on VAP, which found 41.5%, or 24.1 cases per thousand mechanical ventilation days. The incidence rates of VAP are higher in developing countries with limited resources. Australia, South Korea, and Singapore, which belong to Asian-Pacific countries, have the 2nd highest incidence of VAP (16%), followed by Colombia, Mexico, and Chile, which come under Latin American countries (13.8%). Studies published in China from 2010 to 2015 were selected for comprehensive review and meta-analysis, which demonstrated an incidence density of 24.14 episodes per thousand ventilator days. Likewise, another meta-analysis done in 2019 for the VAP rates in 22 Asian countries stated a higher VAP

rate in low-income countries compared to higher-income countries [2,3].

Beginning stage Ventilator-associated pneumonia is typically less serious, related to a superior guess, and bound to be brought about by antibiotic delicate microorganisms. Late-beginning ventilator-associated pneumonia is normally brought about by multi-drug-resistant (MDR) microorganisms and is related to increased mortality and morbidity. Numerous examinations from India have explored the causative microorganisms of ventilator-associated pneumonia. Klebsiella pneumoniae, Acinetobacter spp., Pseudomonas spp., Staphylococcus aureus, and Escherichia coli were recognized as the basic ventilator-associated pneumonia microorganisms. The normal VAP rates described by Indian studies extended from 8.9 to 46 ventilator-associated pneumonia rates for every thousand mechanical ventilation days. Ventilator-associated pneumonia infection is common in the ICU, affecting 8–20 percent of all ICU patients and up to 27 percent of patients on mechanical ventilation [4,3].

In a study done in Karnataka, they have 44% VAP incidence. Researcher David D.M. Rosario from the Medical Sciences and Research Center performed research on the non-tracheostomy patients admitted to the ICU, where he found that 31 (53.44%) out of 58 patients developed VAP. VAP is increasing daily at a rate of 1-3% per day of intubation, and 30–60% of the deaths associated with infection are related to VAP. There will be difficulty weaning off the ventilators and a longer stay in the hospital, which is considered a financial burden to patients as well as their family members [5].

In Belagavi, many studies were performed related to VAP. The studies done by a group of experts on the topic of VAP in the medical ICU found that, out of 54 patients, early onset of VAP was 39.62% and late onset was 60.38% [5].

VAP is constantly connected with raise in morbidity and mortality, clinical length of stay, and expenses. VAP can occur at any moment during ventilation; however, it develops frequently in the initial days after intubation. This is on the grounds that the intubation cycle itself adds to the advancement of VAP. Despite the fact that VAP has different risk factors, applying proper intervention at the right time can help reduce the VAP rate. The concept of proper mouthwash and tooth brushing is based on the fact that delivering evidence-based interventions reliably and consistently will improve patient care.

The primary goal in health institutions, especially in intensive care units, is to decrease the pace of ventilator-associated pneumonia. Among precisely ventilated patients, 20% develop ventilator-associated pneumonia. To control the Ventilated Associated Pneumonia most of the health institution primarily go for sedation, spontaneous breathing trails, deep vein thrombosis prophylaxis, stress ulcers prevention, head elevation of bed and mouth wash management.

Proper mouth wash or oral care is the first line of defense in preventing the VAP. The researcher found that, together with other health care procedures, oral care plays a key role in preventing VAP because many of the interventions are part of routine care. VAP is a preventable illness that, if prevented in time, can diminish the hospital stay, cost, rate of death, and rate of illness. So, here applies the statement, "Prevention is better than cure."

Similarly, while observing the patients on mechanical ventilation, we can frequently notice that they have a dry mouth. In normal, healthy people, oral health is basically maintained by saliva, which has antibacterial, lubricating, and buffering properties. But patients who are on mechanical ventilation have a low rate of saliva production because of the side effects of the treatment they are receiving in terms to recover their health.

VAP occurs because of the aspiration of the oral colonization as a result of poor mouthwash care. After intubation, most of the defense capacity against bacteria is reduced. If proper care is not done there will be collection of secretion which enter into trachea & aspirate into lungs. Within 72 hours, there will be dental plaque depositions on the teeth, which are considered reservoirs for respiratory pathogens. Saliva has important enzymes like lysozyme, which helps to stop bacterial growth. But, in ICU, because of external stressors, there is xerostomia, which increases the risk of carries and periodontal disease.

Most of the research showed that oral care with chlorhexidine solution has been seen as effective in diminishing the incidence of ventilator-

associated pneumonia. Yet, the role of oral care with tooth brushing has sparse consideration and stays indistinct.

2. MATERIALS AND METHODS

The present study was under taken to compare the effectiveness of chlorhexidine mouth wash and chlorhexidine mouth wash with tooth brush in KLE Dr. Prabhakar Kore hospital and MRC, Belagavi, Karnataka. The detailed research methodology adopted for the study, including the methods, tools, and techniques, study area, and procedures in the selection of samples, collection of data, and data analysis, is described below:

2.1 Research Approach

Evaluative approach.

2.2 Study Design

Randomized Controlled Trail.

2.3 Variables under the Study

- Independent Variables: 0.2% chlorhexidine mouth wash solution and tooth brush
- Dependent Variables**:** Ventilated Associated Pneumonia.

2.4 Research Setting

The study was conducted in KLES Dr. Prabhakar Kore Hospital & MRC Belagavi.

2.5 Study Period

November 2019 – March 2021.

2.6 Data Collection Period

19th November 2020 – 19th Feb 2021

2.7 Study Population

Patients who were admitted in Critical Care Unit of Selected Tertiary Care Hospital, Belagavi.

2.8 Sample Size

60 (30 Control group and 30 Study group).

2.9 Sampling Technique

convenient sampling technique.

2.10 Inclusion Criteria

Patients;

- Age between 18 to 70 years.
- being initiated on mechanical ventilation
- relatives who are willing to give consent for research study.

2.11 Exclusion Criteria

- Allergic to the study drug.
- Contraindication for oral care (severe facial trauma, oral injuries/surgery)
- Pregnant women

Death within one week of inclusion in the study.

2.12 Sources

- **Primary sources**: Patients who are admitted in Critical Care Unit of KLE Dr. Prabhakar Kore Hospital and MRC, Belagavi, Karnataka**.**
- **Secondary Sources:** Review of literature collected from various journals, internet and reference books related to mouth wash.

2.13 Tools for Data Collection

Section A: It consists of demographic variables like Age, Gender, Diagnosis, on ventilator more than 48 hours.

Section B: Clinical Pulmonary Infection Score (CPIS).

2.14 Confidentiality

All information collected about participants during the course of the study will be kept confidential. The code numbers will be used in the study records, and the information from this study may be published, but the participants' identities will remain confidential in any publication.

2.15 Data Collection Method

- Permission will be obtained from the concerned authority.
- The investigator will introduce and explain the purpose of the study to the patient's relatives and the care giver.
- Obtain consent from the participants/Family Members.

Chart 1. Clinical Pulmonary Infection Score (CPIS)

S.no.	Test	Score		
		0	1	2
1.	Tracheal secretion	Rare	Abundant	Abundant + Purulent
2.	Chest X-ray infiltrates	No infiltrates	Diffused	Localized
3.	Temperature °C	≥36.5 and ≤38.4	≥38.5 and ≤38.9	≥39 and ≤36
4.	Leukocytes count per mm^3	≥4,000 and ≤11,000	<4,000 or >11,000	<4,000 or >11,000 + band forms ≥500
5.	PaO_2/FiO_2 mmHg	>240 or ARDS		≤240 and no evidence of ARDS
6.	Microbiology	Negative		Positive

Score Interpretation:

- The total CPIS varies from 0-12.
- Where 0 means normal function with little risk of VAP and 12 means high risk of VAP.
- <6 low risk of pulmonary infection
- ≥6 high risk of pulmonary infection

- Data will be collected, tabulated and analyzed.

2.16 Data Collection Procedure

After obtaining the approval of the Ethical Committee and written informed consent, a total of 60 patients who confirmed the inclusion and exclusion criteria were included in the study. The investigator introduces and explains the purpose of the study to the patient's relatives and the care giver.

Patients were randomly divided into two groups: Group A, who would be receiving 0.2% chlorhexidine mouth wash, and Group B, who would be receiving 0.2% mouth wash with tooth brushing, by using a convenient sampling technique.

Group A (Experimental Group) will be given 0.2% chlorhexidine mouthwash twice a day. Here, simple method of mouth wash was followed using sterile swabs. Whereas Group B (Control Group) will receive an equal volume of chlorhexidine with a toothbrush twice a day. Here, a tooth brush was dipped into the chlorhexidine solution, which was further applied for brushing the patient's teeth.

Every day (on 1, 3, 6, 9,12and 15 days), CPIS scoring system was applied for both the groups and followed up by microbiological test including ET gram stain and culture sensitivity to find out whether positive or negative.

3. RESULTS

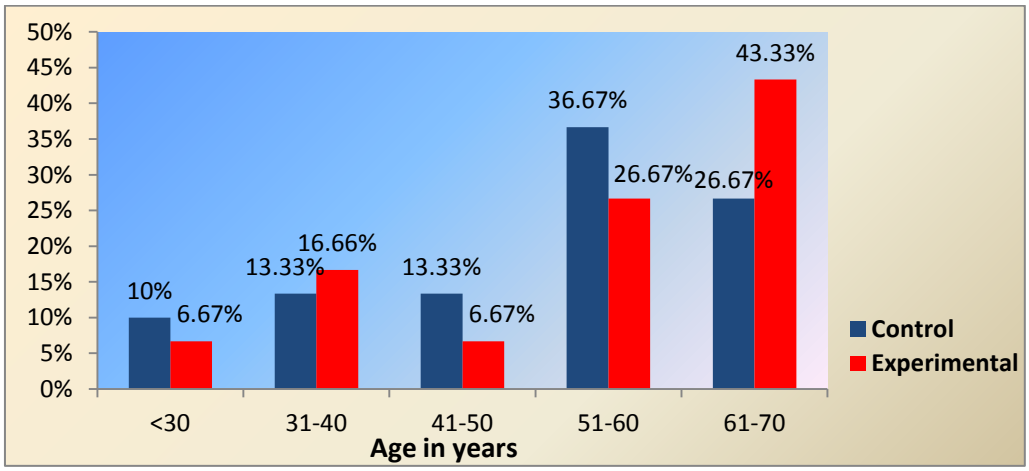
In control group, majority of patient belongs to 51-60 years, i.e. 11 (36.67%) and minority from less than 30 years, i.e. 3(10). Similarly, in experimental group majority of patient belongs to 61-70 years, i.e. 13 (43.33%) and minority from <30 and 41-50 years, i.e.2 (6.67%).

Out of 30 participants, 24 (80%) patients were male and 6 (20%) patients were Female in Control group. Similarly, 23 (76.67%) Male and 7 (23.33%). In both group female participants were less than male.

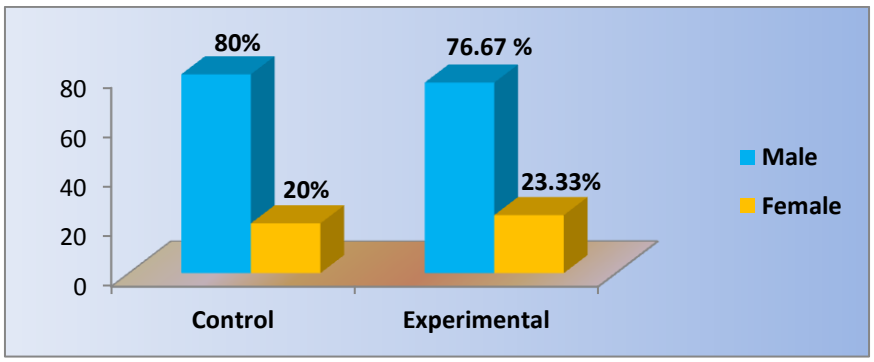
Age in years and gender does not had any significant difference in the result of mouth wash effectiveness with the p value 0.619 and 0.754 respectively which was more than level of significance 0.05. Thus, this result shows hypothesis H_{02} is accepted.

Table 1. Distributions of the study participants according to the age in years (n= 30+30)

S.no	Variables	Control		Experimental		df	P
		F	%	F	%		
1.	**Age in years**						
	<30	3	10	2	6.67		
	31-40	4	13.33	5	16.66		
	41-50	4	13.33	2	6.67	4	0.615
	51-60	11	36.67	8	26.67		
	61-70	8	26.67	13	43.33		
2.	**Gender of Patient**						
	Male	24	80	23	76.67	1	0.754
	Female	6	20	7	23.33		
	Total	30	100	30	100		



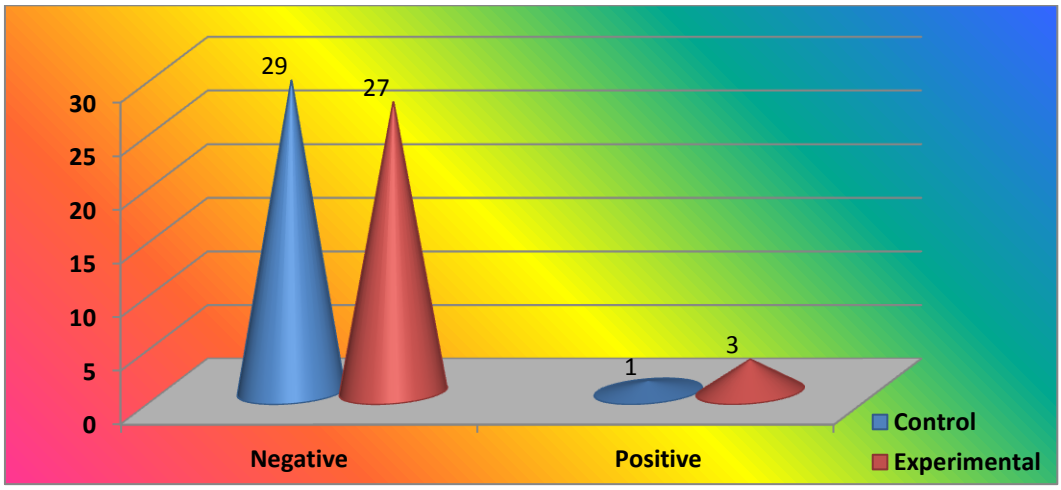
Graph 1. Bar graph of the study participants according to the age in years



Graph 2. Bar graph of the study participants according to the gender

Table 2. Distributions of the study participants according to the microbiology test of ET tube tips (n=30+30)

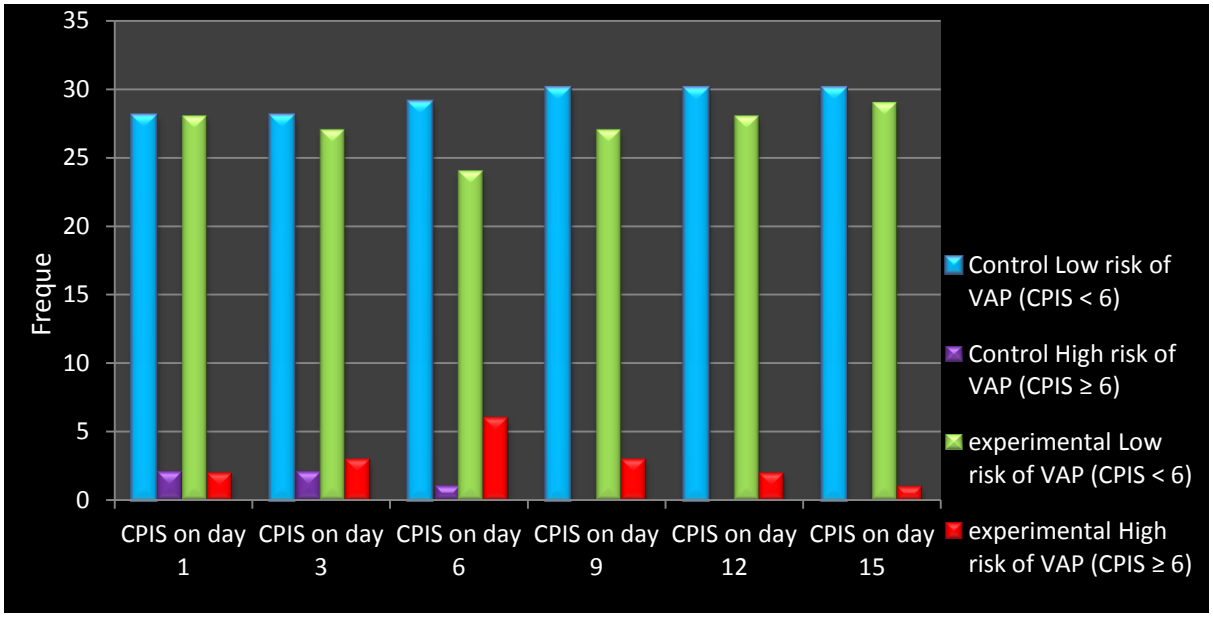
Microbiology test of ET tube tips	Control		Experimental		Df	P
	f	%	F	%		
Negative	29	96.7	27	90	1	0.301
Positive	1	3.33	3	30		
Total	30	100	30	100		



Graph 3. A cone chart of the study participants according to microbiology test

Table 3. Comparing CPIS score and risk of VAP between two groups in days (n=30+30)

Days of CPIS	Control		Experimental		Chi-square test value	df	P
	Low risk of VAP (CPIS < 6)	High risk of VAP (CPIS ≥ 6)	Low risk of VAP (CPIS < 6)	High risk of VAP (CPIS ≥ 6)			
1	28	2	28	2	13.5	6	0.036
3	28	2	27	3	7.6	5	0.180
6	29	1	24	6	35.200	7	0.000
9	30	0	27	3	167.167	4	0.000
12	30	0	28	2	108.300	2	0.000
15	30	0	29	1	56.067	1	0.000



Graph 4. A bar graph comparing CPIS score and risk of VAP between two groups in days

The microbiology test of endotracheal (ET) tube tips came positive more in experimental group 3 (10%) than in control group 1 (3.33%). The p value is 0.301 which shows p value greater than 0.05 level of significance ($p>0.05$). Hence, H_{01} is accepted.

Table 3 clearly explained the comparison between the chlorhexidine group and chlorhexidine with tooth brush on the basis of CPIS score on day 1, 3, 6, 9, 12, 15 and their risk to get VAP. According to the result of Chi-square test, the CPIS score on day 3 was found to be insignificant than in others day with p value more than 0.05. VAP risk was high in Experimental group compare to Control group as the day progressed.

4. DISCUSSION

The aim of the study was to assess the effectiveness of 0.2% chlorhexidine mouthwash and 0.2% chlorhexidine with a tooth brush on patients who were under mechanical ventilation and admitted to the intensive care unit of a selected hospital in Belgaum.

Generally, tooth brushing is a simple activity for health promotion. Tooth brushing has been recommended as a standard care in critically ill patients even though very few evidence to support this practice. Strong evidence supporting the benefit of tooth brushing in intubated, critically ill patients is lacking. Conversely, tooth brushing may allow bacteria to enter the bloodstream because of the potential breakdown of mucosal and gingival tissue, especially in patients with poor dental health. Therefore, most of the researchers concluded that additional research was needed in order to explore the association between oral care and bloodstream infection in patients receiving mechanical ventilation.

However, it is essential to remove the plaque and debris from the oral cavity while performing mouth care for the patient. This is done to avoid the aspiration of the contaminated fluids into the respiratory tract. While giving mouth care, focusing on important aspect like elevating the head of bed and careful use of suction that might be opened or closed fitted with cuff of endotracheal tube is needed most to treat critically ill patient in critical care unit.

Therefore, in order to reduce cases of VAP & to improve the condition of the patient with mechanical ventilators, every health institution must have written oral care protocol & trainings plans to get comprehensive care by patients. The aim of mouthwash and tooth brushing is the regular cleaning of plaque from the teeth twice a day to protect against gingivitis, prevent periodontal disease, and treat xerostomia, ulcers, and candidiasis to prevent VAP.

A study done by Mohanty et al. showed that gender insignificantly influenced the incidence of VAP. Despite this, Rello et al. detected that VAP was higher among males, while Srinivasan et al. concluded that VAP was found to be higher in females [6, 7].

A study conducted on ventilator-associated pneumonia in the ICU of a tertiary care hospital in India by Debaprasad Mohanty et al. found that age did not affect the development of VAP (p-value = 0.929), which was not significant, and that the disease had no preference for gender, which was also not significant (p value = 0.372) [6].

Although there have been many studies done with 0.2% chlorhexidine, the effectiveness of chlorhexidine in preventing VAP incidence is still controversial. One study done by Koeman M and Et al demonstrated that there is decrease in VAP rate by using 0.2% chlorhexidine because it will help in decreasing the pathogenic colonization in the oral cavity. The same researcher further conducted another randomized double-blind study using the same solution (0.2% chlorhexidine) and found chlorhexidine helped reduce the pathogens but not the rate of VAP [8].

Furthermore, recent studies revealed that tooth brushing may not have any effectiveness in preventing VAP or reducing oral pathogens. Munro et al. conducted RCT in an adult patient admitted to an intensive care unit using a 2X2 factorial design. CPIS was used to determine the VAP. The result shows that, from 547 only 249 patients were left for the study by the third day. 24 % developed VAP in the group treated by chlorhexidine with CPIS >=6. After analyzing the data, it shows there was no effect of combination care. In addition, they also declared that the chlorhexidine group with CPIS <6 have the incident of decreased VAP by the third day. Tooth brushing doesn't show any effect on CPIS. The study concluded that chlorhexidine

somehow help in reducing VAP whereas tooth brushing have no any relation [9].

In this study, we have evaluated the clinical diagnosis of VAP assessed by a simplified CPIS using endotracheal tip culture as the reference standard. CPIS more than six has found to be most sensitive for VAP than CPIS less than six. To the best of our knowledge, no data exist regarding the best oral hygiene technique to employ, and our results confirm the fact that more studies on this topic are necessary.

5. CONCLUSION

Based on the analysis of the study, we can conclude that combining tooth brushing with 0.2% chlorhexidine did not provide additional benefit over 0.2% chlorhexidine alone. Thus, VAP remains an important clinical problem in the intensive care unit. Although the finding is not statistically significant, patients who received chlorhexidine with the tooth brushing intervention tended to have higher CPIS values and a higher rate of VAP occurrence in experimental group 3 (10%) than in control group 1 (3.33%).

Due to the possibility that dislodgement of dental plaque microorganisms during tooth brushing could create a bigger pool of microorganisms for movement from the mouth to subglottic secretion or the lung, further examination of the expected risk of tooth brushing is justified. Moreover, the technique of endotracheal tube adjustment and control in the arrangement of oral care is a territory for future research. Thus, further research to prevent VAP is needed.

CONSENT

As per international standard or university standard, patient(s) written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

Institutional review board approval was obtained. Prior to data collection, ethical clearance was obtained from the ethical committee of the KLE Academy of Higher Education and Research, Institute of Nursing Sciences, Belagavi, Karnataka. After obtaining ethical clearance, hospital permission was obtained from the kle dr. Prabhakar Kore hospital and MRC, Belagavi, Karnataka.

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COMPETING INTERESTS

Author has declared that no competing interests exist.

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APPENDIX

Annexure I - Proforma

Title- "effectiveness of chlorhexidine 0.2% mouthwash vs.chlorhexidine 0.2% mouthwash with toothbrush in preventing ventilator associated pneumonia. A one year hospital based randomized controlled trial."

Group: _____

Name & Address of the patient:
_____
_____

Age of the Patient:_____ IP. No. _____
Sex._____
Date of admission:
Diagnosis:
Length of ICU stay:
Date of endotracheal intubation:
No. of days on mechanical ventilation:
Indication for mechanical ventilation: Pulmonary (_____)/Non pulmonary (_____)

Past History:

General Physical Examination:
Pallor:
Icterus:
Cyanosis:

Edema:
Clubbing:
Lymphadenopathy Pulse:
B.P:
RR:
Temperature:

<u>Systemic Examination</u> :

Respiratory System:

Cardiovascular System:

Central Nervous system:

Per Abdomen:

Investigations:

Test	Score					
	Day 1	**Day 3**	**Day 6**	**Day 9**	**Day 12**	**Day 15**
Tracheal secretion						
Chest X-ray infiltrates						
Temperature						
Leukocytes count						
PaO_2/FiO_2						
Microbiology						
Total Score						

Adverse Effect (If any)

_____

Signature of staff in charge

Annexure II – Gantt Chart

Study plan and preparation	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
Title selection	✔	✔																	
Review of literature			✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔			
Synopsis development				✔	✔	✔	✔												
Internal review							✔												
Ethical clearance							✔												
Hospital permission												✔							
External review								✔											
Pilot study												✔	✔						
Data collection and entry													✔	✔	✔	✔			
Data analysis																✔			
Dissertion writing																✔	✔		
Plagiarism check																	✔		
Submission of dessertion																	✔	✔	
Publication																			

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