

## Gargling with *Aloe vera* extract is effective to prevent the Ventilator-Associated Pneumonia (VAP)

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### ABSTRACT

**Background:** Long-term use of a mechanic ventilator may cause *Ventilator-Associated Pneumonia* (VAP) infection, nosocomial pneumonia that occurs after 48 hours in patients using mechanical ventilation either through the endotracheal tube or the tracheostomy tube. To prevent the occurrence of VAP, antiseptic liquid (mouthwash) such as chlorhexidine 2% maybe recommended. However, gargling using chlorhexidine may also cause allergies, thus, *Aloe vera* extract could be an alternative.

**Aims:** The purpose of this study was to determine the effectiveness of *Aloe vera* extract as mouthwash to prevent the occurrence of Ventilator-associated pneumonia.

**Methods:** This research is a quasi-experiment case-control study with a pre-posttest control group design. The sample size in this study was 30 respondents who were equally distributed into two groups; intervention group was administered using *Aloe vera* extract, while chlorhexidine was practiced for the control group. To determine the occurrence of VAP, Clinical Pulmonary Infection Score (CPIS) for Ventilator-Associated Pneumonia was measured on the first day of intubation and the fourth day, enumerated by nurses in the emergency room. CPIS is a set of indicators comprised of temperature, leucocyte, trachea secretion, oxygenation (PaO<sub>2</sub>/FiO in mm Hg), and thorax photo. CPIS value below than five will be regarded non-VAP, while CPIS scored 6-9 will be diagnosed as VAP.

**Results:** Oral hygiene with *Aloe vera* extract was able to prevent the occurrence of VAP (p-value = 0.001), but there was no significant difference between the control group and intervention in the CPIS component temperature, leukocytes, tracheal secretions, FiO<sub>2</sub>, and the thoracic component.

**Conclusions:** Oral hygiene with *Aloe vera* extract effectively prevented the occurrence of *Ventilator-Associated Pneumonia* (VAP) compared to chlorhexidine.

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## INTRODUCTION

A mechanical ventilator is a set of airway aid to maintain ventilation and oxygen administration for a long time [1]. The use of ventilator will cause

infectious disease, one of which is *Ventilator-Associated Pneumonia* (VAP). VAP is an inflammation of the lungs (pneumonia) caused by the use of a ventilator for a long time in patients [2, 3]. VAP is pneumonia nosocomial that occurs after 48 hours in patients with the help of mechanical

ventilation either through the endotracheal tube or tracheostomy tube [4]. The incidence of VAP in patients who received mechanical ventilation was around 22.8% and accounted for 86% of cases of nosocomial infection [5]. Previous studies reported the occurrence of VAP ranged between 36.8 to 42 percent with 50 to 80 percent fatalities [6, 7]. Most of VAP incidence occurred among patients with ventilator who required antibiotics, suction, hand washing, changes in sleeping position, and oral hygiene to prevent oral decontamination. Studies found, antiseptics is more recommended than antibiotics considering the risk of resistance of VAP-causing bacteria [8, 9].

According to The Institute for Healthcare Improvement (IHI), antiseptic liquid recommended for oral hygiene is Chlorhexidine 2%. Nevertheless, long-term use chlorhexidine may also cause side effects namely tooth discoloration, restoration, and mucous membranes increased calculus formation, taste disturbances, burning sensation, and mucosal irritations [10]. The negative effects most patients complain of Chlorhexidine is the appearance of stains on the teeth, mouth and cheek mucosa after 2 weeks of use. In addition, gargling using Chlorhexidine can also cause irritation to the oral mucosa, burning sensation, and changes in taste perception [11].

*Aloe vera* has been proven as an alternative substance for mouthwash in patients with ventilator exposure. It contains active components which include anthraquinone, Aloesin, aloin, Aloeemodin, acemanan, saponin, sterols, amino acids, minerals, aminoglycosides, and enzymes that beneficial for health. Antibacterial activity of *Aloe vera* inhibits bacterial growth, both gram-positive and gram-negative bacteria. *Aloe vera* also has antimicrobial power in *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Candida albicans*, *Klebsiella pneumoniae*, *Enterococcus faecalis*, and *Micrococcus luteus* [12]. The use of *Aloe vera* as an antiseptic for oral hygiene has been done in mice and in vitro animals but has never been done to humans directly. In a study conducted by Pandey, that ethanol extract from *Aloe vera* produced a greater growth inhibition zone (29-30mm) than water extract (3-4mm) against organisms including *Enterococcus bovis* and *Staphylococcus aureus* 14. Based on the description above, the study aims to find out the effectiveness of gargling with *Aloe vera* extract in patients with ventilator in preventing the occurrence of VAP.

## METHODS

The study uses a case-control study with a pre-posttest design with a sample size of 30 respondents which equally divided into case and control group. Sample is ventilator-associated pneumonia patients with endotracheal tube tracheostomy in 3 general hospitals in Central Java of Indonesia, namely RSUD Dr. Loekmono Hadi Kudus (12 samples), RSA RAA Soewondo Pati (10 samples), and RSUD Dr. Soetrasno Rembang (8 samples), who were selected consecutively from the population. Patients with HIV-AIDS and previous history of pneumonia were excluded from the study.

The intervention group was administered to gargling twice a day using 10 ml *Aloe vera* extract as mouthwash, while the control group used 10ml chlorhexidine 2%. To determine the occurrence of VAP, Clinical Pulmonary Infection Score (CPIS) for Ventilator-Associated Pneumonia was measured on the first day and the fourth day of intubation, enumerated by nurses in the emergency room. CPIS is a set of indicators comprised of temperature, leucocyte, trachea secretion, oxygenation (PaO<sub>2</sub>/FiO<sub>2</sub> in mm Hg), and thorax photo. CPIS value below than five will be regarded non-VAP, while CPIS scored 6-9 will be diagnosed as VAP. Procedures performed in this research received approval from Health Research Ethic Commission of Politeknik Kesehatan Kemenkes Semarang on March 29<sup>th</sup>, 2018 with number 040/KEPK/Poltekkes-Smg/EC/2018.

## RESULTS

Table 1 shows homogeneous data variations between the intervention and the control group ( $p$  value >0.05). Data found that the majority of respondents were elderly, aged more than 65 years (40%). Generally, respondents in the intervention group are older than those in the control group. Of 30 participants, 16 respondents were male (53.3%). While intervention group was dominated by male, the control group was mostly comprised of females. From medical diagnosis data, most respondents having CHF medical diagnoses (26.7%). Although there was a slight difference on the diagnosis, however, most of respondents in both groups are suffered from CHF. About 13 percent of males also diagnosed with stroke hemorrhagic and head injury, while about a fourth of female diagnosed with pulmonary edema. Moreover, the majority noted staying at the hospitals for 4 and 5 days, while only 1 patient stayed for 6 days.



**Table 1.** Respondents' characteristics (N=30)

Characteristics	Total		Case	Control	p value	
	N	%	%	%		
<b>Age</b>						
36-45	7	23.3	13.3	33.3	0.682	
46-55	5	16.7	6.7	26.7		
56-65	6	20	33.3	6.7		
> 65	12	40	46.7	33.3		
<b>Gender</b>						
Male	16	53.3	66.7	40.0	0.478	
Female	14	46.7	33.3	60.0		
<b>Medical diagnosis</b>						
CHF	8	26.7	26.7	26.7	0.856	
Head injury	3	10	13.3	6.7		
Pleural effusion	1	3.3	6.7	0		
Chronic renal failure	3	10	6.7	13.3		
Hepatomegaly	1	3.3	6.7	0		
Pulmonary edema	5	16.7	6.7	26.7		
Post-surgery	2	6.7	6.7	6.7		
Sepsis	1	3.3	6.7	0		
Stroke hemorrhagic	3	10	13.3	6.7		
Stroke nonhemorrhagic	2	6.7	6.7	6.7		
Preeclampsia	1	3.3	0	6.7		
<b>Length of stay</b>						
4 days	15	50	53.3	46.7		0.353
5 days	14	46.7	46.7	46.7		
6 days	1	3.3	0			

**Table 2.** Mean difference of CPIS components before and after oral hygiene in intervention and control groups (N=30)

CPIS components	Intervention		Control		p value**
	Mean difference (±SD)	p value*	Mean difference (±SD)	p value*	
Temperature	0.773±0.846	0.002	0.5±0.240	0.001	0.138
Leukocytes	-1.853± 10.180	0.492	-0.85 ±2.210	0.157	0.713
Oxygenation Pao <sub>2</sub> /FiO <sub>2</sub>	-43.190±143.640	0.262	-32.66± 139.750	0.381	0.840
Tracheal secretions	-0.667± 0.258	0.317	0.067± 0.798	0.739	0.089
Thorax photo	0.670± 0.488	1.000	0.20 ± 0.414	1.000	0.011

\* Peer T-test comparing the mean value before and after treatment of each group; \*\*Independent T-test comparing the mean difference between the intervention and control group

**Table 3.** Total CPIS score before (pretest) and after (post-test) mouthwash administration (N=30)

Group	Total CPIS score		p value
	Pretest	Post-test	
Intervention	4.07±1.100	3 ±1.195	0.001
Control	3.87 ±1.246	3.53±1.187	0.465

Table 2 shows that temperature was the only component of CPIS that has a significant difference after the administration of mouth wash. Other CPIS components such as leukocyte, oxygenation, tracheal secretion and thorax photo showed no difference counted on the first (pretest) and fourth day (post-test) of observation. As shown in Table 3, after the administration of *Aloe vera* extract (intervention group) and chlorhexidine 2% (control group), there was a significant difference on the mean CPIS score in the intervention group with p-value 0.001 whereas in the control group, there was no significant changes (p-value of 0.465). Clinical assessment after the administration of mouthwash in the intervention groups ranged from 0 to 5 which means *Aloe vera* extract prevents the occurrence of VAP.

## DISCUSSION

Congestive Heart Failure (CHF) is one of the cardiovascular system diseases in which the conditions on the cardiovascular system are closely related to the respiratory system where the heart is unable to pump blood in sufficient quantity to maintain smooth circulation. Consequently, blood builds up and extra pressure that causes fluid to accumulate into the lungs. When the lungs have lost function, it requires a breathing apparatus such as a mechanical ventilator [13]. One of the factors causing the occurrence of VAP was the use of an extended breathing apparatus [14]. Strict monitoring and supervising the maintenance of VAP bundle are required to reduce the incidence of VAP infection [15].

The respondents of the study were fitted with mechanical ventilators only for 4 days because the respondent is ready to breath without assistance. Weaning is carried out to avoid side effects due to ventilator installation, shorten the length of stay, and reduce the cost of care.

The finding of the study indicated that *Aloe vera* extract reduces body temperatures. Prior the intervention, there was no significant difference of temperatures between intervention and the control group ( $p$  value = 0.252). The administration of *Aloe vera* extract effectively reduced the body temperatures of patients in the intervention group ( $p$  value <0.05). According to Kowalak, an increase in temperature occurs when the infectious agent enters the body. An increase in temperature will help fight infection because many microorganisms cannot live in high

temperature environments. If the body temperature rises too high, the body's cells can be damaged [13].

There was no significant difference of leucocyte counts between the intervention and the control group ( $p$  value > 0.05). Leukocytes are white blood cells that form blood components. White blood cells function to help the body fight various infectious diseases as part of the immune system. The body reacts to the entry of pathogenic microorganisms by increasing the number and type of white blood cells. The inflammatory response that occurs after 48 hours of trauma shows a risk of the appearance of VAP [16]. In this study, reduction in the number of leukocytes was higher in the control group. However, it should be noted that the increased leukocytes is one form of the body's defense against microorganisms due to the installation of a ventilator. Gargling with *Aloe vera* extract twice a day can maintain the cleanliness of the upper cavity of the patient so as to minimize the proliferation of pathogenic germs in it. According to Augustyn, the mucosal injury due to intubation and a decrease in the body's ability to filter and moisturize the air in the airways causing disruption of mechanisms clearance from cilia in cleansing. The presence of ET will provide a place for bacteria to enter the trachea. The next condition of these things will increase mucus production and secretion.

There was no significant difference of secretory component between intervention and control group. *Aloe vera* as an antiseptic against several bacteria in the oral cavity allows reducing the number of secretions in the trachea which will naturally produce excess secretions which can affect the ventilation and oxygenation processes so that they can increase PaO<sub>2</sub> / FiO<sub>2</sub> to patients with ventilators mechanical [16].

The mean oxygenation of the intervention group was greater than the control group although there was no significant difference with a  $p$  value > 0.05. Research by Wang suggests that chest radiographs have a deficiency in diagnosing pulmonary consolidation because changes in radiographic features can be affected by positive end-expiratory pressure (PEEP) in a fraction of inspiring oxygen in the use of ventilators mechanical. One lung disease causing infiltrates pneumonia which causes the lungs to become inflamed and filled with fluid. Chest X-ray is a major investigation to diagnose pneumonia by finding a radiological picture of an infiltrate. The diagnosis of VAP is most often based on the presence of a new or progressive infiltrate in chest X[5, 14].

There is no significant difference in CPIS score that describes the incidence of VAP between groups. The occurrence of VAP in the control group with chlorhexidine, showed that none of the respondents experienced VAP, because the content of chlorhexidine was capable of killing VAP-causing bacteria. However, the administration of *Aloe vera* extract to intervention group showed that there were no respondents who experienced VAP with reference to CPIS scores.

*Aloe vera* consists of antimicrobial aminoglycosides which have the ability to kill germs. Saponin and aminoglycoside compounds will diffuse on bacterial cell walls. This process takes place continuously in an aqueous atmosphere and will be forwarded to the ribosome which produces protein and will then cause the breakdown of protein bonds of bacterial cells. *Aloe vera* gel has many properties and is unique with great medicinal value and very few side effects. Therefore it is definitely recommended in the treatment of numerous oral mucosal diseases [17]. *Aloe vera* can be used as mouthwash to prevent plaque stomatitis and gingivitis, because the inhibitory power of *Aloe vera* is able to kill gram positive and negative bacteria, and *Aloe vera* is a safe, natural material and no side effects.

According to IHI in patients with mechanical ventilators other than ETT, decreased consciousness, and loss of cough reflexes, microorganisms can develop because of the presence of dental plaque biofilms due to lack of or loss of mechanical functions namely chewing and reduced or even absence of saliva which can minimize biofilm development in the tooth. Dental plaque can be a reservoir for potential respiratory pathogens that cause VAP [18].

*Aloe vera* also serves as an effective as chlorhexidine in reducing plaque and gingivitis [19]. Medium concentration of the *Aloe vera* extract in the study shows that the effect size of *Aloe vera* extract is better than the honey solution which has an effect size of 0.18. Hexadol gargle is effective in preventing the occurrence of VAP, but hexadol gargle with a value size of 3.46 but has a disadvantage that should not be given to patients who are allergic to hexetidine. Chlorhexidine is oral hygiene recommended by IHI, but the FDA has issued a rule for every Chlorhexidine manufacturer to attach a warning label about allergies [20].

Although the results if the study showed a positive indication of *Aloe vera* extract, limitation of the study also should be addressed. A selection bias could be a

threat since most of sample in the case or intervention group are older than sample in the control group. Moreover, unequal proportion of males-females which actually has different risk of VAP should also be considered for further research and investigation.

## CONCLUSION

Gargling with *Aloe vera* extract effectively prevents the occurrence of a Ventilator-Associated Pneumonia ( $p$  value = 0.001) compared to Chlorhexidine. *Aloe vera* extract can be used as an alternative antiseptic to maintain oral hygiene of ventilator-attached patients in preventing Ventilator-Associated Pneumonia.

## CONFLICT OF INTERESTS

The authors declare no conflict of interest.

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