

Original Research Article

Effects of path-based oral care combined with compound chlorhexidine gargle on oral hygiene, comfort and intubation-related complications in ICU patients undergoing tracheal intubation

Ying Wang¹, Shuang Chen¹, Shuang Qiao¹, Xiaoqian Liu², Yingli Zhang¹, Yueyu Zhang^{1*}

¹Central Intensive Care Unit, ²Operating Room, Shanghai East Hospital, Shanghai, China

*For correspondence: **Email:** Zhangyueyu819@163.com; **Tel:** +86-018516690819

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Abstract

Purpose: To assess the effect of path-based oral care combined with compound chlorhexidine gargle on oral hygiene, comfort and intubation-related complications in patients in intensive care unit (ICU) undergoing tracheal intubation.

Methods: One hundred and fifty intensive care unit patients receiving tracheal intubation at Shanghai East Hospital ICU, Shanghai, China were split into study group (routine chlorhexidine gargle 0.2 % with additional path-based oral care) and control group (routine chlorhexidine gargle 0.2 %). This approach was evaluated for its impact on intubation-related complications. Oral health and care effects were assessed before and after a 14-day nursing period. Comparisons were made between the groups for oral cleanliness, mucosa state and odontopathy, Beck and VAS scores, oral odor, inflammation proportions, and post-nursing complications.

Results: Before nursing, there was no significant difference in oral health status and oral care between the two groups ($p > 0.05$). However, after nursing, scores of oral health status and indices increased and decreased in both groups, respectively. The scores for oral health status in the study group were significantly higher than those in control group, while the scores of the oral study indices were significantly lower than those in control group ($p < 0.05$). After nursing, however, the proportions of patients with oral odor and oral inflammation and the incidence of intubation-related complications in the study group were lower than those in the control group ($p < 0.05$).

Conclusion: Path-based oral care combined with compound chlorhexidine gargle improves oral care effect and comfort, and reduces the incidence of intubation-related complications in ICU patients undergoing tracheal intubation. This study will need to be conducted in a larger population in the future to validate these findings.

Keywords: Path-based oral care, Compound chlorhexidine gargle, Tracheal intubation, Oral care

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INTRODUCTION

Transcatheter orotracheal intubation is an important means of critical care medicine utilized

to rescue critically ill patients with respiratory failure, airway obstruction and respiratory arrest [1]. In recent years, with the rapid development of critical care medicine in China, this practice

has become an effective measure in establishing the respiratory channel and maintaining vital signs and is now widely used in the intensive care unit (ICU) [2]. Patients' awareness of oral cleaning before intubation is poor and the oral cavity also lacks self-cleansing function during intubation surgery. The bacteria that colonize the oral cavity rapidly proliferate at the optimum growth conditions. In addition, the oral secretions as well as bacteria already colonizing the oral cavity move down the periphery of the tracheal intubation, which further induces lung infection and may also cause other complications that further aggravate the pain of the patients [3]. The main component of compound chlorhexidine gargle is chlorhexidine, which is a broad-spectrum antimicrobial agent that effectively alleviates the postoperative oral infection complications seen in such patients [4]. Traditional forms of oral care mostly use the rinsing method or cotton ball rinsing care. However, the efficacy of these traditional methods is not significant as the patient's oropharyngeal bacteria cannot be eliminated. In addition, there are nursing difficulties and limitations, and the risk of dislocation or displacement of the patient's endotracheal tube exists [5]. Pathway oral care is a high-level nursing model that takes the perioperative period as an overall prevention and control period and carries out pathway oral care and sensory control management for patients in study group according to time points [6]. In this study, the effect of pathway oral care combined with chlorhexidine rinsing, and chlorhexidine rinsing alone on oral hygiene, comfort and intubation-related complications in ICU patients with tracheal intubation were compared.

METHODS

General information

One hundred and fifty ICU patients on tracheal intubation, treated at the Shanghai East Hospital, Shanghai, China, from January 2020 to January 2023, were selected as subjects for this study. They were divided into a study group (75 cases) and a control group (75 cases) according to the admission time. This study was approved by the Ethics Committee of Shanghai East Hospital (approval no. 2023045). The patients and their families were informed and gave their consent.

Inclusion criteria

The following categories of patients were included in the study: patients who needed to be intubated and mechanically ventilated via ICU; patients who were 18 years or older); patients

who had the appropriate oral care within one day of mechanical ventilation and patients who cooperated with the whole process in the study.

Exclusion criteria

The study excluded patients falling within the following categories: Patients who had suffered from oral diseases or lung diseases before intubation; those who had undergone tracheal intubation within 30 days of the study commencement; those who died in less than 72 h of tracheal intubation; patients with immunodeficiency or hypoplasia; those who had recently used immunosuppressive drugs; patients who suffered from advanced cancers; those who had less than 6 natural teeth; and those who were suffering from impaired consciousness and could not cooperate with the study.

Intervention

Control group

Compound chlorhexidine gargle solution (0.2 %) was used to moisten some medical cotton balls and the moistened medical cotton balls were used to care for the oral cavity. The patient was placed in the supine position, with the head of the bed vertically raised about 30°. The patient's head was guided to turn to one side and then the patient was intubated endotracheally. Thereafter, the pressure of the intubating airbag was stabilized at about 30 cm H₂O. It was ensured that the depth of the patient's tracheal tube insertion was safe and effective, and the respiratory vaporizer was then used for continuous humidification to ensure that the temperature at the proximal end of the airway was about 37 - 37.5 °C. The patient's mouth was cleaned with a child's soft-bristled toothbrush dipped in a small amount of toothpaste (which did not affect the oral solution). A syringe, with the needle removed, was filled with the oral solution and connected to a suction tube to slowly rinse out the oral cavity and the secretions in the oral cavity then suctioned out. At the same time, the patient's head and intubation were secured by using the forehead or jaw as the fulcrum, while the tethered strap, tape and patient's dental pads that secured the tracheal intubation tube were removed [6]. Next, a suction tube was used to perform lateral suction from all areas of the patient and medical cotton balls moistened with cotrimoxazole were used to wipe the inner and outer surfaces of the patient's teeth, tongue, cheeks and palate, controlling the appropriate humidity of the cotton balls, approximately 5 times per day. During the

cleaning process, the dental pads were diligently changed while the dental pads and endotracheal tube were fixed promptly. Nursing care was carried out throughout the patient's intubation period.

Study group

In addition to the treatment administered to control group, pathway nursing, which is used to improve patients' oral care outcomes, was carried out. The steps for the pathway nursing oral care are itemized as follows: Establish a pathway nursing team; analyze and solve common tracheal intubation problems; develop a program to guide oral care practice [8]; timely correction and improvement of problems related to the nursing process and pathway care.

Evaluation of parameters/indices

Oral hygiene status

The patient's oral hygiene status was assessed using the Oral Hygiene Scoring System in the Nursing Outcome Classification System before and after care, respectively [7]. The scale includes 3 dimensions, (namely: oral cleanliness (6 items), oral mucosa (6 items) and dental disease (7 items)), a total of 19 indicators, with each indicator assigned between 1 - 5 points and a total possible score of 95 points. Lower scores indicate a poor oral hygiene status. The scale Cronbach's α coefficient is 0.796.

Oral study parameters

Beck oral scoring scale [8] and pain visual analogue (VAS) scoring scale [9] were used before and after care to compare the oral function and pain status of patients in the study and control groups, respectively. Beck oral scoring scale was divided into five dimensions: lips, gingiva and oral mucosa, tongue, teeth and saliva, with a score of 1 - 4 points for each item, and the total score of less than 5 points indicates a good oral function, 6 - 10 points indicate oral function is mildly disturbed, 11 - 15 points indicate moderate disturbance of oral function, and 16 - 20 points indicate severe disturbance of oral function. The pain visual analogue scale (VAS) has a full score of 10 points and the higher the degree of pain, the lower the oral comfort, and the higher the score.

Effectiveness of oral care

The effect of oral care on patients in study group, according to the number of cases of oral odor

and oral inflammation, was compared with control group at the end of nursing.

Complications related to intubation

The occurrence of complications related to intubation (catheter dislodgement, catheter leakage, tracheal blockage, sore throat and lung infection) between the study and control groups at the end of nursing care were compared.

Data analysis

Statistic Package for Social Science (SPSS), version 22.0 software (IBM, Armonk, NY, USA) was used to process the data. Measurement data (oral hygiene scores and oral study indicators) were compared using the *t*-test, and count data (oral care effect and the incidence of intubation-related complications) were compared using the Chi-squared (χ^2) test. $P < 0.05$ indicates statistical significance.

RESULTS

General information about patients

Comparison of the general information of patients showed no statistically significant difference in mean age and intubation mode between study group and control group ($p > 0.05$; Table 1).

Oral hygiene

Before nursing, the patients in the study and control groups had comparable oral hygiene scores in all dimensions, and the difference was not statistically significant ($p > 0.05$). However, at the end of nursing, the scores of the patients in both groups increased with patients in study group having higher scores than the patients in control group in all dimensions of oral hygiene. This increase was not significant ($p < 0.05$). The results are highlighted in Table 2.

Oral study indices

Before care, Beck oral scores and visual analogue of oral pain (VAS) scores of patients in the study and control groups were comparable, and the difference was not statistically significant ($p > 0.05$). At the end of care, Beck oral and VAS scores of patients in both groups were reduced, and both scores of patients in study group were statistically lower than those of control group ($p < 0.05$; Table 3).

Table 1: Comparison of general patient data

Group	Gender (male/Female)	Age (years)	Intubation mode	
			Transoral	Transanal
Control	40/35	32.15±3.76	36	39
Study	39/36	32.64±4.01	37	38

Table 2: Comparison of oral hygiene status of patients

Group	Oral cleanliness		Oral mucosa		Dental disease	
	Pre-care	Post-care	Pre-care	Post-care	Pre-care	Post-care
Control	22.43±3.15	24.05±1.62*	21.29±2.38	23.11±1.24*	28.19±2.05	33.26±1.75*
Study	22.37±3.08	26.81±1.57*	21.15±2.17	25.06±1.93*	27.86±1.94	31.59±1.84*
<i>T</i>	0.118	10.595	0.376	7.362	1.013	5.695
<i>P</i> -value	0.906	<0.001	0.707	0.000	0.313	<0.001

P* < 0.05 vs. pre-careTable 3:** Comparison of oral study indices of patients

Group	Beck Oral Score		Oral VAS score	
	Pre-care	Post-care	Pre-care	Post-care
Control	17.12±1.24	13.47±1.53*	3.87±1.19	2.69±0.73*
Study	17.26±1.18	10.15±1.24*	3.79±1.23	1.76±0.85*
<i>T</i>	0.708	14.599	0.405	7.188
<i>P</i> -value	0.48	<0.001	0.686	<0.001

P* < 0.05 vs. pre-careOral care effect**

At the end of care, the incidence of oral inflammation caused by herpes and ulcers in patients of the study and control groups was comparable, and the difference was not statistically significant ($p > 0.05$). However, the incidence of oral inflammation in patients in study group was lower than that in control group and

the difference was statistically significant ($p < 0.05$; Table 4).

Incidence of intubation-related complications

At the end of care, the incidence of intubation-related complications in patients of study group was 22.67 %, which was statistically lower than 48.00 % in control group ($p < 0.05$; Table 5).

Table 4: Comparison of the effectiveness of oral care for patients in both groups

Group	Oral odor	Oral inflammation		
		Mold	Herpes	Ulcers
Control	16 (21.33)	13 (17.33)	5 (6.67)	3 (4.00)
Study	7 (9.33)*	4 (5.33)*	2 (2.67)*	0 (0.00)*
χ^2	4.160	5.374	1.349	3.061
<i>P</i> -value	0.041	0.020	0.246	0.080

P* < 0.05 vs. controlTable 5:** Incidence of intubation-related complications in the study population

Group	Trachea blockage	Catheter prolapse	Catheter leakage	Sore throat	Lung infection	Total incidence
Control	4 (5.33)	8 (10.67)	7 (9.33)	13 (17.33)	4 (5.33)	36 (48.00)
Study	2 (2.67)*	5 (6.67)*	2 (2.67)*	6 (8.00)*	2 (2.67)*	17 (22.67)*
χ^2						10.533
<i>P</i> -value						0.001

**P* < 0.05 vs. control

DISCUSSION

Establishing an artificial airway for mechanical ventilation is an important rescue measure for patients with respiratory failure or critical illness and the most commonly used method is transoral intubation or transnasal tracheal intubation [10]. Tracheal intubation is a respiratory assistive technique in which a specially designed endotracheal tube is introduced into the trachea via the voice box and connected to a mechanical ventilator, which is now widely used in the rescue treatment of ICU patients and can significantly improve the symptoms of hypoxia and acid-base imbalance as well as prevent aspiration [11-13]. Since ICU patients are generally in critical condition, immunocompromised, have poor self-care ability and have a long duration of illness, factors such as endotracheal intubation and nasogastric feeding can lead to changes in the oral environment and stimulate salivary secretion [14]. Moreover, the oral mucosa of patients on mechanical ventilation via orotracheal intubation is exposed to air for a long time. Due to the dryness of the oral mucosa, the ability of the oral cavity to self-clean and protect itself decreases drastically, which, if not properly cared for, will easily cause residual impurities or plaque to form in the oral cavity, produce odor and even cause complications such as oral ulcers and related pneumonia [15,16].

Studies have shown that chlorhexidine gargle at a concentration of 0.2 % produces the best result as it increases the friction of the tooth surface. In combination with oral care scrubbing, chlorhexidine inhibits the synthesis of dextran, effectively removes plaque and at the same time reduces oral colonization of bacteria, which is less likely to cause oral mucous membrane irritation, tooth staining, bacterial resistance and other undesirable conditions [17]. The implementation of pathway-based care further standardizes nursing care, helps nursing staff carry out nursing activities with foresight, reduces the blindness of nursing work and improves work efficiency and patient satisfaction [18].

This study shows that before nursing care, the oral hygiene condition and oral study indices of patients in the study and control groups were comparable. After nursing care, the scores of oral hygiene condition and oral study indices in all dimensions of patients in both groups increased and decreased, respectively. However, the scores of the oral hygiene condition of patients in study group were significantly higher than those in control group, while the oral study indices were significantly lower than those in control group. It is proposed that both types of

oral care help to improve the effect of patients' oral care [11].

The oral hygiene and cleanliness, oral comfort and oral function of patients in study group were better than those in control group. This may be because although the mucus secreted by the human oral mucosa has a certain antiseptic effect, the perioperative patients' mouths being exposed to air also come in contact with a large number of bacteria or mold. In addition, the reduction of water loss in the mucous membranes prevents dryness and contributes to a decrease in mucus secretion. These combined effects work synergistically to enhance the quality of the patient's oral health. The mucous membrane thus becomes dry due to water loss, thereby reducing the secretion of mucus, which leads to the deterioration of patients' oral hygiene.

Coral solution has a bacteriostatic effect as it effectively removes gram-positive and gram-negative bacteria in the patient's oral cavity so that the oral hygiene and comfort of the two groups of patients are improved compared with before care. The pathway care combined with oral solution is more rigorous and standardized than that of oral solution alone, which standardizes the nursing process. The nursing process of pathway nursing combined with oral solution gargle solution is stricter and more standardized than that of oral solution gargle solution alone, which prevents risky conditions during the incident and improves the nursing effect. The occurrence of risky conditions during the patient's treatment or hospitalization is significantly reduced, leading to a notable improvement in the effectiveness of nursing care.

This study showed that the percentage of patients with oral odor, the number of patients with oral inflammation and the incidence of intubation-related complications were significantly lower ($p < 0.05$) in study group than in control group aftercare. The study also showed that the overall incidence of adverse conditions in patients in study group was lower than that of control group. This may be due to the addition of the pathway nursing model with the use of oral solution gargle. It enhanced the ability of nursing care to ensure that the patient's tracheal intubation surgery was carried out smoothly.

Limitations of this study

The major limitation of this study is the number of patients involved in the study. Secondly, only a single center was used for the study. Therefore,

the findings of this study cannot be applied to a general population.

CONCLUSION

Pathway oral care combined with oral solution improves the oral cleanliness, oral mucosa and dental scores of patients on tracheal intubation in ICU. Both combinations also improve patients' oral care and their comfort, reducing the incidence of Beck's Oral Score, Oral VAS Score, and complications related to intubation aftercare. This study will need to be conducted in a larger population in the future to validate its findings.

DECLARATIONS

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Ethical approval

None provided.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflict of Interest

No conflict of interest associated with this work.

Contribution of Authors

We declare that this work was done by the authors named in this article and all liabilities pertaining to claims relating to the content of this article will be borne by the authors. Ying Wang and Shuang Chen contributed equally to this work.

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REFERENCES

- Morkenborg ML, Kristensen MS. Tube tip in pharynx - a conduit for awake oral intubation in patients with extremely restricted mouth opening. *Can J Anesth* 2022; 69(4): 504-508.
- Lin YJ, Xu L, Huang XZ, Jiang F, Li SL, Lin F, Ye QY, Chen ML, Lin JL. Reduced occurrence of ventilator-associated pneumonia after cardiac surgery using preoperative 0.2 % chlorhexidine oral rinse: results from a single-center single-blinded randomized trial. *J Hosp Infect* 2015; 91(4): 362-366.
- Scannapieco FA, Cantos A. Oral inflammation and infection, and chronic medical diseases: implications for the elderly. *Periodontol* 2000 2016; 72(1): 153-175.
- Rajendiran M, Trivedi HM, Chen D, Gajendrareddy P, Chen L. Recent Development of Active Ingredients in Mouthwashes and Toothpastes for Periodontal Diseases. *Molecules* 2021; 26(7): 2001. doi: 10.3390/molecules26072001
- Linhartova L, Michalikova K, Sredlova K, Cajthaml T. Biodegradability of Dental Care Antimicrobial Agents Chlorhexidine and Octenidine by Lignolytic Fungi. *Molecules* 2020; 25(2): 400. doi: 10.3390/molecules25020400.
- Pretty IA, Ellwood RP, Lo EC, MacEntee MI, Muller F, Rooney E, Murray TW, Van der Putten GJ, Ghezzi EM, Walls A, et al. The Seattle Care Pathway for securing oral health in older patients. *Gerodontology* 2014; 31 Suppl 1: 77-87.
- Johnson M, Maas M. The Nursing Outcomes Classification. *J Nurs Care Qual* 1998; 12(5): 9-20, 85-87.
- Singh P, Arshad Z, Srivastava VK, Singh GP, Gangwar RS. Efficacy of Oral Care Protocols in the Prevention of Ventilator-Associated Pneumonia in Mechanically Ventilated Patients. *Cureus J Med Sci* 2022; 14(4): e23750.
- Lin L, Wang R, Chen T, Deng J, Niu Y, Wang M. Failure mode and effects analysis on the control effect of multi-drug-resistant bacteria in ICU patients. *Am J Transl Res* 2021; 13(9): 10777-10784.
- Zhang P, Liu LP. Design of assessment tool for unplanned endotracheal extubation of artificial airway patients. *Nurs Open* 2021; 8(4): 1696-1703.
- Wu J, Liu Z, Shen D, Luo Z, Xiao Z, Liu Y, Huang H. Prevention of unplanned endotracheal extubation in intensive care unit: An overview of systematic reviews. *Nurs Open* 2023; 10(2): 392-403.
- Dexter F, Macario A, Dexter EU. Computer simulation of changes in nursing productivity from early tracheal extubation of coronary artery bypass graft patients. *J Clin Anesth* 1998; 10(7): 593-598.
- Ogawa M, Satomi-Kobayashi S, Yoshida N, Tsuboi Y, Komaki K, Nanba N, Izawa KP, Inoue T, Sakai Y,

- Akashi M, et al. *Impact of Oral Health Status on Postoperative Complications and Functional Recovery After Cardiovascular Surgery*. *Cjc Open* 2021; 3(3): 276-284.
14. Terano K, Motoi T, Nagata E, Oho T. Association of remaining tooth number with postoperative respiratory complications in heart valve surgery patients. *Int J Dent Hyg* 2023; doi: 10.1111/idh.12673.
 15. Nakamura Y, Tagusari O, Seike Y, Ito Y, Saito K, Miyamoto R, Nakano K, Shikata F. Prevalence of periodontitis and optimal timing of dental treatment in patients undergoing heart valve surgery. *Interact Cardiovasc Th* 2011; 12(5): 696-700.
 16. Zhang TT, Tang SS, Fu LJ. The effectiveness of different concentrations of chlorhexidine for prevention of ventilator-associated pneumonia: a meta-analysis. *J Clin Nurs* 2014; 23(11-12): 1461-1475.
 17. Alhazzani W, Smith O, Muscedere J, Medd J, Cook D. Toothbrushing for critically ill mechanically ventilated patients: a systematic review and meta-analysis of randomized trials evaluating ventilator-associated pneumonia. *Crit Care Med* 2013; 41(2): 646-655.
 18. Thoma DS, Naenni N, Figuero E, Hammerle C, Schwarz F, Jung RE, Sanz-Sanchez I. Effects of soft tissue augmentation procedures on peri-implant health or disease: A systematic review and meta-analysis. *Clin Oral Implants Res* 2018; 29 Suppl 15: 32-49.