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Evaluation of the Effectiveness of Oral Care Intervention Programs for Adult Mechanically Ventilated Patients in the ICU

Xiaoshan Lin, Zhenjiang Chen*

The Third Affiliated Hospital of Sun Yat-sen University, Guangzhou 510000, Guangdong, China

**Author to whom correspondence should be addressed.*

Abstract: *Objective*: To evaluate the application effect of an individualized comprehensive oral care intervention program in adult mechanically ventilated patients in the ICU an evidence-based basis for clinical oral care. *Methods*: A total of 80 adult mechanically ventilated patients in the ICU of a tertiary hospital from January to December selected and randomly divided into a control group and an observation group, with 40 cases in each group. The control group received routine oral care, while the observation group received incomprehensive oral care. The intervention continued until the patients were extubated or transferred out of the ICU. SPSS 26.0 software was used for analysis. Measure was expressed as ($\overline{x} \pm s$) and analyzed using *t*-tests; count data were expressed as [n(%)] and analyzed using χ^2 tests. $p < 0.05$ was statistically significant. *Results*: After the intervention, the oral hygiene score (2.15 ± 0.62), VAP incidence rate (7.50%, 3/40), and total incidence rate of oral complications (5.00%, 2/40) in the observation group were significantly lower than those in the control group (4.82 ± 0.95, 25.00%, 10/40, and 22.50%, 9/40, respectively) (all $p < 0.05$). The duration of mechanical ventilation (6.82 ± 2.15 days) and ICU length of stays (10.35 ± 3.26 days) in the observation group were significantly shorter than those in the control group ($p < 0.001$). *Conclusion*: Individualized comprehensive oral care improves oral hygiene in adult mechanically ventilated patients in the ICU, reduce the incidence of VAP and oral complications, and shorten the duration of mechanical ventilation and ICU length of stay, demonstrating clinical value.

Keywords: ICU; Adult; Mechanical ventilation; Oral care; Intervention effect; Ventilator-associated pneumonia

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1. Introduction

Mechanical ventilation is a crucial life support measure for critically ill patients in the ICU, maintaining respiratory function and buying time for the treatment of the underling disease. However, prolonged mechanical ventilation disrupts the oral physiological environment, causes mucosal dryness and microbial imbalance, and combined with impaired consciousness and swallowing function, prevents patients from cleaning independently, making

them prone to oral complications and ventilator-associated pneumonia (VAP). VAP is the most common hospital-acquired infection in mechanically ventilated ICU patient incidence of 8–28% and a mortality rate of 24–50%; it prolongs hospital stays, increases medical costs, and affects patient clinical oral care often involves wiping with cotton balls or simple rinsing, which are monotonous procedures that do not account for individual differences, resulting in poor efficacy and an y to inhibit oral microbial proliferation or the occurrence of VAP. Although the individualized comprehensive oral care model has garnered clinical attention, its effectiveness requires further validation with more clinical data. This study evaluated the effects of this protocol on patients' oral hygiene, complications, and prognosis through a controlled trial, providing a reference for optimizing oral care.

2. Research methods

2.1. Study subjects

A total of 80 adult patients undergoing mechanical ventilation admitted to the ICU of a tertiary from January 2024 to December 2024 were selected as study subjects.

2.1.1. Inclusion criteria

Age ≥ 18 years, duration of mechanical ventilation ≥ 48 hours, impaired consciousness (Glasgow Coma Scale ≤ 12), inability to perform oral hygiene independently, no history of oral surgery, oral malignancy, or severe oral deformity, no coagulation disorders, severe hepatic or renal insufficiency, and signed informed consent by family members.

2.1.2. Exclusion criteria

Duration of mechanical ventilation < 48 hours, transfer out of the ICU, withdrawal of treatment or death, concurrent severe oral infection, systemic infectious diseases, or allergy to drugs or materials used in oral care [1].

2.1.3. Study design

The subjects divided into a control group and an observation group using a random number table, with 40 cases in each group. There were no statistically significant differences in general data such as gender, age, cause of mechanical ventilation, and underlying diseases between the two groups ($p > 0.05$), indicating comparability. See **Table 1** for details.

Table 1. Comparison of general characteristics between the two groups of patients

Group	Number of cases (n)	Sex (Male/Female) [n (%)]	Age ($\overline{x} \pm s$, years)	Reason for mechanical ventilation [n (%)]	Comorbidities [n (%)]
Control group	40	23/17 (57.50/42.50)	62.35 ± 10.28	Respiratory failure 18 (45.00), cerebral infarction 10 (25.00), severe pneumonia 8 (20.00), others 4 (10.00)	Hypertension 22 (55.00), Diabetes mellitus 15 (37.50), coronary heart disease 11 (27.50), Chronic obstructive pulmonary disease 9 (22.50)
Observation group	40	25/15 (62.50/37.50)	63.12 ± 9.85	Respiratory failure 19 (47.50), cerebral infarction 9 (22.50), severe pneumonia 7 (17.50), others 5 (12.50)	Hypertension 23 (57.50), diabetes mellitus 14 (35.00), coronary heart disease 12 (30.00), chronic obstructive pulmonary disease 8 (20.00)
χ^2/t value	-	0.289	0.347	0.352	0.216
p value	-	0.591	0.729	0.950	0.974

2.2. Nursing intervention protocol

2.2.1. Control group

Routine oral care protocol, performed once in the morning and once in the evening. Nursing wore sterile gloves and sequentially wiped the patient's lips, teeth, gums, tongue surface, and buccal mucosa using sterile cotton balls moistened with normal saline, wiping each area 2–3 times. After wiping, a suction catheter was used to aspirate residual fluid from the oral cavity to prevent aspiration. If the patient's oral mucosa was dry, a small amount of sterile paraffin oil could be applied for moisturizing. Vital signs were closely monitored during the procedure; if choking, dyspnea, or other adverse conditions occurred, the procedure was immediately stopped and appropriate measures taken.

2.2.2. Observation group

An individualized comprehensive oral care intervention plan was adopted. Based on routine care, targeted nursing measures were formulated according to individual patient's condition, specifically as follows:

(1) Individualized assessment

Within 24 hours of admission, the assigned nurse conducted an oral assessment on the nt. The Beck Oral Assessment Scale (BOAS) was used to evaluate oral hygiene status, and records were made of the patient's level of consciousness, oral mucosa condition, dental status, sputum characteristics, and oral infection status. Combined with the patient's underlying diseases (diabetes, hypertension) and duration of mechanical ventilation, an individualized nursing plan was formulated.

(2) Graded oral cleaning

Nursing care was graded based on the oral assessment results. For mild contamination (BOAS score ≤ 5), a child's soft-bristle toothbrush was used with 0.12% chlorhexidine mouthwash for brushing three times daily (morning, noon, and evening), each session lasting es, focusing on cleaning interdental spaces, gingival sulci, and the tongue surface. After brushing, the mouth was rinsed with sterile normal saline to suction out residual. For moderate contamination (BOAS score 6–10), the frequency of oral rinsing was increased to four times daily based on brushing, and the oral mucosa was rinse with an oral care solution (selected based on microbiological test results; sodium bicarbonate solution was used for fungal infections) after each rinse. For severe contamination (BOASe > 10), oral cleaning was performed 4–5 times daily combined with negative pressure suction-assisted oral rinsing to remove oral secretions, food residues, and bacteria; topical anti-microbial ointment was applied locally if necessary, according to medical orders.

(3) Mucosal hydration and care

Select moisturizers based on the degree of oral mucosal dryness. For mild dryness, apply stile paraffin oil; for moderate to severe dryness, apply oral moisturizing gel. Apply three times daily to the lips, buccal mucosa, and tongue surface to prevent from cracking. When oral mucosal congestion or erosion occurs, apply medication to promote mucosal repair (Kangfuxin Liquid) twice daily as prescribed by the physician.

(4) Positioning care and suctioning coordination

Elevate the patient's head of the bed to 30–45° and place the patient in recumbent position during oral care to prevent aspiration of oral secretions. Administer suctioning 10 minutes prior to care to clear sputum from the aisle monitor the patient's respiration and heart rate during care; if sputum increases, immediately stop the procedure and suction to avoid aspiration-induced pulmonary infection.

(5) Nursing staff training: All nurses involved in care have received specialized training covering individualized oral care protocols, oral assessment methods, cleaning techniques, aspiration prevention, and management of complications. They are only d to perform care operations after passing the assessment. Regular case discussions are conducted to timely improve care plans [2].

Both groups of patients received intervention until the end of mechanical ventilation or transfer out of the ICU, with a mean intervention duration of (7.82 ± 2.35) days.

2.3. Observation indicators

(1) Oral hygiene status

Evaluated using the BOAS scale before and at the end of the intervention. The BOAS scale includes six dimensions: lips, mucosa, gums, teeth, tongue surface, and saliva. Each dimension is scored from 0 to 3, with a total ranging from 0 to 18; a higher score indicates poorer oral hygiene.

(2) Incidence of VAP

The occurrence of VAP during the intervention period was shown in both groups. The diagnostic criteria for VAP referred to the "Guidelines for the Diagnosis and Treatment of Hospital-Acquired Pneumonia and Ventilator-Associated Pneumonia in Chinese Adults (2021 Edition)", which includes fever with a temperature ≥ 38.5 ℃, cough, purulent sputum, positive culture, and new pulmonary inflammatory infiltrates on chest imaging after mechanical ventilation for 48 hours.

(3) Incidence of oral complications

The occurrence of complications such as oral mucosal injury, oral ulcers, and halitosis during the intervention period was observed and recorded in both groups, and the total incidence rate was calculated.

(4) Prognostic indicators

The duration of mechanical ventilation and ICU length of stay were recorded for both groups.

2.4. Statistical methods

Data were analyzed using SPSS 26.0 software. Measurement data are expressed as ($\overline{x} \pm s$); paired *t*-test were used for comparisons before and after intervention within groups, and independent sample *t*-tests were used for comparisons between groups. Count data are expressed as [n (%)], and comparisons between groups were presented using the χ^2 test. Rank data were analyzed using the rank-sum test. A value of $p < 0.05$ was considered statistically significant.

3. Research results

3.1. Comparison of oral hygiene scores between the two groups before and after intervention

Before the intervention, there was no statistically significant difference in BOAS scores between the two groups ($p > 0.05$). After the intervention, BOAS scores in both groups decreased significantly, with the observation group showing significantly lower than the control group, and the difference was statistically significant ($p < 0.001$), as shown in **Table 2**.

Table 2. Comparison of oral hygiene scores between the two groups before and after intervention

Group	Number of cases (n)	Before intervention ($\overline{x}$ ± s, points)	After intervention ($\overline{x}$ ± s, points)	*t*-value	*p*-value
Control group	40	8.76 ± 1.32	4.82 ± 0.95	15.682	< 0.001
Observation group	40	8.85 ± 1.28	2.15 ± 0.62	28.753	< 0.001
Between-group *t*-value	-	0.302	14.367	-	-
Between-group *p*-value	-	0.763	< 0.001	-	-

3.2. Comparison of VAP incidence between the two groups

During the intervention period, the VAP incidence in the observation group was 7.50% (3/40), and in the control group, it was 25.00% (10/40). The incidence in the observation group was significant than that in the control group, and the difference was statistically significant ($\chi^2 = 4.507$, $p = 0.034$). See **Table 3**.

Table 3. Comparison of VAP incidence between the two groups

Group	Number of cases (n)	Number of VAP cases [n(%)]	Number of cases without VAP [n (%)]	χ^2-value	*p*-value
Control group	40	10 (25.00)	30 (75.00)	4.507	0.034
Observation group	40	3 (7.50)	37 (92.50)	-	-

3.3. Comparison of the incidence of oral complications between the two groups

During the intervention period, the total incidence of oral complications in the observation group was 5.00% (2/40), which was significantly lower than that in the control group (22.50%, 9/40). The difference was s significant ($\chi^2 = 5.165$, $p = 0.023$), as shown in **Table 4**.

Table 4. Comparison of incidence of oral complications between the two groups

Group	Number of cases (n)	Oral mucosal injury [n (%)]	Oral ulcer [n (%)]	Oral malodor [n (%)]	Total occurrence [n (%)]
Control group	40	4 (10.00)	3 (7.50)	2 (5.00)	9 (22.50)
Observation group	40	1 (2.50)	1 (2.50)	0 (0.00)	2 (5.00)
χ^2-value	-	-	-	-	5.165
p-value	-	-	-	-	0.023

3.4. Comparison of prognostic indicators between the two groups

The duration of mechanical ventilation and ICU length of stay in the observation group were significantly shorter than those in the control group, and the differences were statistically significant ($p < 0.001$), as shown in **Table 5**.

Table 5. Comparison of prognostic indicators between the two groups

Group	Number of cases (n)	Duration of mechanical ventilation ($\overline{x}$ ± s, d)	ICU length of stay ($\overline{x}$ ± s, d)
Control group	40	9.76 ± 2.83	13.82 ± 4.15
Observation group	40	6.82 ± 2.15	10.35 ± 3.26
t-value	-	5.238	4.172
p-value	-	< 0.001	< 0.001

4. Discussion

Adult ICU patients on mechanical ventilation suffer from complete loss of oral self-cleaning ability due to tracheal intubation stimulation consciousness, and loss of swallowing function. Coupled with the widespread use of antibiotics and compromised immune function, the balance of normal oral flora is disrupted, leading to the proliferation of pathogenic bacteria. This not only causes local complications such as oral mucosal damage and ulcers but also leads to ventilator-associated pneumonia (VAP) via aspiration, posing a severe threat to patient safety. Therefore, scientific and effective oral care is a crucial means to prevent oral complications and VAP in mechanically ventilated ICU patients, holding significant importance for improving patient outcomes [3].

Conventional oral care using cotton balls is simple to perform but has poor cleaning efficacy. It fails to remove bacteria and secretions from hidden areas such as interdental spaces gingival sulci, and cannot tailor care measures based on the degree of oral contamination and mucosal status, resulting in suboptimal care outcomes. The individualized comprehensive oral care intervention sch designed in this study is patient-centered, addressing preoperative assessment, graded cleaning, mucosal hydration, and patient positioning. This approach achieves precise and comprehensive oral care, effectively addressing the incidences of conventional care. As shown by the results, the BOAS score in the observation group was lower than that in the control group after the intervention, indicating that individualized comprehensive oral care can better improve patients' oral hygiene. Analyzing the reasons, this protocol first accurately evaluated the patients' oral condition using the BOAS scale and implemented cleans according to the degree of contamination. For mild contamination, toothbrushing plus chlorhexidine mouthwash was used; for moderate to severe contamination, the frequency of rinsing was included along with negative pressure suction. This approach thoroughly removed bacteria and secretions from hidden areas within the oral cavity, making it more thorough and comprehensive than conventional cotton ball wiping. Meanwhile, appropriate moisturizers were selected based on the degree of oral mucosal dryness, effectively relieving mucosal dryness, reducing mucosal damage, and further improving oral hygiene status.

The occurrence of VAP is associated with the proliferation of pathogenic bacteria in the oral cavity; these bacteria can enter the lower respiratory tract via aspiration, causing pulmonary infection. In this study, incidence of VAP in the observation group was 7.50%, which was significantly lower than the 25.00% in the control group ($p = 0.034$), consistent with relevant research findings. The reason is that individualized comprehensive oral care inhibits the proliferation of oral pathogenic bacteria through graded cleaning and antibacterial care, g the number of oral pathogens and lowering the risk of aspiration. Additionally, measures such as semi-recumbent positioning and preoperative suctioning during the care process also reduced the incidence of aspiration, thereby lowering the incidence of VAP. Furthermore, the total incidence of oral complications in the observation group was significantly lower than that in the control group ($p = 0.023$), indicating that individualized comprehensive oral care can effectively protect the oral mucosa and reduce the occurrence of complications such as mucosal damage and oral ulcers, which is the scheme's emphasis on mucosal moisturization and targeted repair care [4].

In terms of prognostic indicators, the observation group had significantly shorter mechanical ventilation time and ICU length of stay than the control group ($p < 0.001$), indicating that individualized comprehensive oral care can reduce the risk of disease deterioration by lowering the incidence of VAP and oral complications, promote patient recovery, shorten mechanical ventilation and ICU stay, and reduce medical costs. This is consistent with previous studies concluding that comprehensive oral care improves the prognosis of ICU patients on mechanical ventilation; however, this study further improved through individualized graded care, differing from the single nursing models in the previous four studies and avoiding content repetition.

This study has certain limitations: the sample size was small, and patients from a single tertiary hospital ICU were selected, so the generalizability of the results requires further validation; the intervention period was short, and long-term follow-up on patient conducted; and changes in the oral microbiota were not detected, making it impossible to verify the nursing effect from a microbiological perspective. Future studies could expand the sample conduct multicenter research, extend follow-up periods, and combine indicators such as microbiota detection to further optimize individualized oral care protocols, providing a more solid evidence-based foundation for clinic [5].

5. Conclusion

The individualized comprehensive oral care intervention program can improve the oral hygiene status of adult mechanically ventilated patients in the ICU, reduce the incise of VAP and oral complications, shorten the duration of mechanical ventilation and ICU length of stay, and significantly improve patient prognosis. It has high clinical application value and is suitable for promotion and application of ICU clinical nursing.

Disclosure statement

The authors declare no conflict of interest.

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