Journal of Clinical and Nursing Research, 2026, Volume 10, Issue 3
http://ojs.bbwpublisher.com/index.php/JCNR
Online ISSN: 2208-3693
Print ISSN: 2208-3685

Construction of an Integrated Oral Care and Swallowing Stimulation Protocol for Comatose Patients with Cerebral Hemorrhage

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Abstract: *Objective*: This study aims to design and establish a comprehensive intervention protocol that combines oral care with swallowing stimulation for comatose patients with cerebral hemorrhage. The core objectives are to systematically control the risk of aspiration pneumonia, improve the oral health environment of patients, and explore its potential supportive role in the early awakening process. *Methods*: The study was conducted using a mixed-methods approach. The first phase involved integrating systematic literature reviews with Delphi expert consultations to establish the basic components and specific operational norms of the protocol. The second phase implemented a non-randomized concurrent controlled clinical trial, enrolling 112 eligible comatose patients with cerebral hemorrhage, evenly divided into an intervention group and a control group, with 56 patients in each group. The intervention group received a newly constructed integrated protocol of oral care and swallowing stimulation for four weeks, while the control group maintained standard oral care routines in the neurology department. The core observational indicators included the Clinical Pulmonary Infection Score (CPIS), Oral Assessment Scale (OAS) scores, changes in the Glasgow Coma Scale (GCS) scores, and analysis of microbial colony counts in saliva. Data were analyzed using SPSS 25.0 software, with continuous variables conforming to a normal distribution presented as mean ± standard deviation. Comparisons between groups were made using independent sample *t*-tests or non-parametric Mann-Whitney U tests, and repeated measures analysis of variance was used for repeated measurement indicators. *Results*: After the four-week intervention period, data analysis revealed that the CPIS values in the intervention group were significantly lower than those in the control group, with statistical significance. In terms of oral health assessment, the intervention group showed significantly greater improvement than the control group. The intervention group also demonstrated a more pronounced upward trend in consciousness level scores. Microbiological test results confirmed that the survival numbers of opportunistic pathogens in the saliva of the intervention group were effectively controlled. *Conclusion*: The integrated protocol of oral care combined with swallowing stimulation constructed and preliminarily validated in this study has been shown to effectively reduce the clinical probability of aspiration pneumonia in comatose patients with cerebral hemorrhage, optimize oral microecological balance, and potentially promote improvement in consciousness status. This protocol holds potential value for translation into routine clinical practice.

Keywords: Cerebral hemorrhage; Comatose state; Oral hygiene care; Swallowing function stimulation; Intervention protocol; Aspiration pneumonia

Online publication: Apr 21, 2026

1. Introduction

Coma caused by cerebral hemorrhage poses a severe challenge in neurological intensive care. Due to the suppression of higher nervous activities, patients experience a decline in protective reflex functions such as swallowing and coughing, leading to a near-paralysis of oral self-cleaning mechanisms. This significantly increases the risk of aspiration of oropharyngeal secretions into the lungs, with aspiration pneumonia emerging as a critical complication affecting the survival rate and rehabilitation quality of these patients. While current routine nursing practices focus on basic oral hygiene, they generally lack a systematic strategy that integrates prevention, treatment, and functional preparation based on the unique neurophysiological states of comatose patients. Recent academic perspectives suggest that, in addition to strengthening oral management, incorporating standardized swallowing pathway-related stimulation may produce additive effects in promoting arousal and swallowing function reserves by acting on specific nerve nuclei and conduction pathways, beyond maintaining oral hygiene. Currently, there is a lack of an integrated, standardized, and easily executable combined intervention protocol in domestic clinical settings. Therefore, this study focuses on developing and preliminarily validating an integrated oral care and swallowing stimulation protocol specifically tailored for comatose patients with cerebral hemorrhage, aiming to establish a novel structured nursing model that effectively manages complications and may positively influence neurological outcomes.

2. Materials and methods

2.1. General information

The study subjects were comatose patients with cerebral hemorrhage admitted to the neurological intensive care unit of our hospital from June 2022 to December 2023. Inclusion criteria required a definitive diagnosis of spontaneous cerebral hemorrhage confirmed by imaging, a Glasgow Coma Scale (GCS) score between 5 and 8 at enrollment, an expected survival time exceeding four weeks, and no history of significant oral diseases or swallowing problems prior to onset. Ultimately, 112 patients were enrolled and randomly assigned to either the intervention group or the conventional group, with 56 patients in each group. The baseline characteristics, including age distribution, gender ratio, specific location of cerebral hemorrhage, initial coma score, and Acute Physiology and Chronic Health Evaluation (APACHE) score, showed no statistically significant differences between the two groups, ensuring comparability of initial states.

2.2. Protocol development method

The development of the combined intervention protocol followed evidence-based medicine principles and was closely integrated with clinical practice. A multidisciplinary team comprising neurologists, rehabilitation therapists, senior specialist nurses, and oral surgeons was established at the beginning of the study. The team systematically reviewed relevant domestic and international literature, comprehensively collecting the latest research advancements on oral hygiene management, swallowing reflex stimulation, aspiration prevention, and neuro-promotion techniques in comatose patients. After a comprehensive assessment of existing evidence, a draft protocol covering four core components, namely the initial assessment, oral care execution, swallowing stimulation implementation, and effect monitoring was drafted. Subsequently, two rounds of Delphi method expert consultations were conducted, involving 15 authoritative experts in neurocritical care nursing, neurorehabilitation, and critical infection prevention from renowned domestic medical institutions. These experts provided quantitative ratings and textual

revisions on the necessity, operability, and specific details of each item in the draft protocol. Based on the central tendency, degree of coordination, and specific suggestions from expert feedback, the protocol underwent multiple rounds of adjustments and optimizations until consensus was reached, resulting in the final executable version.

2.3. Intervention protocol content

The finalized protocol is a standardized twice-daily nursing process. Each intervention begins with a comprehensive assessment of oral status. The oral care component emphasizes adjusting the patient's position, maintaining a 30-degree head-of-bed elevation with the patient's head turned to the side, using specialized oral care tools with integrated suction and 0.12% chlorhexidine mouthwash to perform thorough, region-specific cleaning without omissions, focusing on areas with plaque accumulation while ensuring lubrication and moisturization of the buccal mucosa. The swallowing stimulation component is initiated after ensuring oral cleanliness, absence of foreign bodies, and stable vital signs, following these sequential steps:

(1) Cold stimulation, using sterile ice cotton swabs to gently and rapidly contact and stimulate the bilateral palatopharyngeal arches, base of the tongue, and posterior pharyngeal wall;
(2) Neuromuscular electrical stimulation, employing low-frequency electrical stimulation devices to apply mild current stimulation to electrodes attached to the relevant muscle groups of the mandible and neck;
(3) Passive motion training, performing slow opening and closing and lateral movements of the temporomandibular joint within a pain-free range for the patient. All procedures must be executed according to standard protocols and fully documented.

2.4. Evaluation indicators and statistical methods

The study's evaluation system integrates clinical, functional, and microbiological indicators. The primary outcome measure is the Clinical Pulmonary Infection Score (CPIS), used to objectively quantify pneumonia risk and severity. Secondary outcome measures include: the Oral Assessment Guide (OAG) score to reflect overall oral condition; monitoring dynamic changes in the Glasgow Coma Scale score to assess the level of consciousness; and collecting saliva samples from patients before intervention initiation and at the end of the fourth week of intervention for bacterial culture and colony quantification analysis. All collected data were entered by two individuals independently and blindly. Statistical analysis was performed using SPSS 25.0 software. Normally distributed quantitative data were described using mean ± standard deviation, with independent samples *t*-tests used for between-group comparisons and paired *t*-tests for within-group before-and-after comparisons. Data not conforming to a normal distribution were presented as median and interquartile range, with non-parametric test methods employed. Categorical data comparisons were made using the chi-square test. A p-value less than 0.05 was set as the threshold for statistical significance.

3. Results

3.1. Comparison of aspiration pneumonia risk between the two groups of patients

In the intervention group, patients' CPIS scores were significantly lower than those in the conventional group at both the second and fourth weeks after intervention, with the score gap between the two groups gradually widening over time. Detailed data comparison results are shown in **Table 1**.

Table 1. Comparison of clinical pulmonary infection scores between the two groups at different time points

Group	Number of cases	Before intervention	Week 2	Week 4	*F* value (Time)	*p* value (Interaction)
Intervention group	56	3.15 ± 0.82	2.40 ± 0.81	1.85 ± 0.74	38.124	< 0.001
Control group	56	3.05 ± 0.94	2.98 ± 0.90	2.90 ± 0.95	0.723	0.487
t value	-	0.583	3.698	6.452	-	-
p value	-	0.561	< 0.001	< 0.001	-	-

3.2. Comparison of oral health conditions between the two groups of patients

The scoring results from the Oral Assessment Guide clearly demonstrate that the combined intervention measures significantly promote oral health in comatose patients. After the intervention, patients in the intervention group showed substantial improvements in their comprehensive scores for oral mucosal moisture, dental plaque control, and gingival health status. In contrast, patients in the conventional group exhibited only slight improvements or even declines in their oral condition scores. The difference in scores between the two groups reached a highly statistically significant level at the end of the fourth week of intervention. For a detailed comparative analysis of the data, please refer to **Table 2**.

Table 2. Comparison of oral assessment guide scores before and after intervention between the two groups of patients

Group	Number of cases	Before intervention	At week 4 of intervention	*t* value (intra-group)	*p* value (intra-group)
Intervention group	56	18.50 ± 3.30	11.30 ± 2.61	14.225	< 0.001
Conventional group	56	18.60 ± 3.12	17.95 ± 3.50	1.102	0.275
t value (Inter-group)	-	0.162	10.947	-	-
p value (Inter-group)	-	0.872	< 0.001	-	-

3.3. Comparison of changes in consciousness states between the two groups of patients

In terms of monitoring consciousness levels, the Glasgow Coma Scale (GCS) scores of patients in both groups changed over the four-week period, but the intervention group demonstrated a more favorable trend of improvement. The average increase in scores for patients in the intervention group was greater than that in the conventional group, particularly in subcategories such as motor response and verbal response (for individuals with faint responses). For specific data comparisons, please refer to **Table 3**.

Table 3. Comparison of changes in Glasgow coma scale scores before and after intervention between the two groups

Group	Number of cases	Pre-intervention	Week 4 of intervention	Score change value
Intervention group	56	6.48 ± 1.05	7.72 ± 1.40	+1.24 ± 0.85
Control group	56	6.35 ± 1.15	6.79 ± 1.32	+0.44 ± 0.88
t/*Z* value	-	0.618	3.675	4.832*
p value	-	0.538	< 0.001	< 0.001

Note: The Mann-Whitney U test was used for between-group comparisons of score changes.

3.4. Comparison of salivary microbiological test results between the two groups of patients

The microbiological test results provided objective biological evidence of the intervention's effects. At the end of the fourth week of intervention, the total number of bacterial colonies cultured from saliva samples, as well as the positive detection rates and specific colony counts of common opportunistic pathogens such as *Klebsiella pneumoniae* and *Pseudomonas aeruginosa*, were significantly lower in the intervention group than in the conventional group (**Table 4**).

Table 4. Comparison of major opportunistic pathogen colony counts in saliva between the two groups at week 4 of intervention

Group	No. of cases	Klebsiella pneumoniae	Pseudomonas aeruginosa	Staphylococcus aureus	Candida albicans
Intervention group	56	75 (15, 200)	45 (5, 140)	25 (0, 90)	40 (5, 110)
Conventional group	56	880 (420, 1600)	550 (250, 950)	200 (60, 450)	220 (90, 400)
Z value	-	-6.304	-5.976	-5.418	-5.102
p value	-	< 0.001	< 0.001	< 0.001	< 0.001

4. Discussion

The integrated approach of oral care combined with swallowing stimulation, developed and validated in this study, has demonstrated preliminary data supporting its effectiveness in reducing aspiration pneumonia, enhancing oral health, regulating microbial communities, and potentially aiding in the improvement of consciousness among patients. This achievement breaks through the limitations of traditional care, which primarily focuses on local cleaning, and represents a shift towards a more comprehensive, proactive, and neurophysiologically compatible approach to nursing for patients with cerebral hemorrhage-induced coma [1].

The primary finding is the outstanding role of the approach in pneumonia prevention. The significant decrease in the Clinical Pulmonary Infection Score directly reflects the powerful preventive capability of the combined intervention against aspiration and related pulmonary infections. This effectiveness stems from the dual mechanisms inherent in the approach. Firstly, meticulous and standardized oral care procedures, employing both physical removal and chemical inhibition, significantly reduce the number of pathogenic bacteria in the oropharynx and destabilize biofilms, effectively intercepting contamination at its source. Secondly, programmed stimulation of the swallowing area, by activating sensory receptors in sensitive regions of the pharynx, may play a role in maintaining pharyngeal reflex sensitivity and enhancing the potential tension of muscle groups related to airway protection, thereby constructing a more effective defense line at the functional level. These two mechanisms complement each other, jointly establishing a more comprehensive "source control-pathway enhancement" dual protection mechanism than simple oral cleaning alone [2].

The combined intervention measures have a clear positive regulatory effect on oral microecology. The improvement in oral assessment scale scores and the reduction in the number of pathogenic bacteria in saliva collectively confirm the transition of the oral environment towards a healthier state. Coma patients often experience oral flora imbalance due to various factors. The application of chlorhexidine in this approach creates broad antimicrobial conditions, while regular and thorough oral cleaning prevents the continuous development of dental plaque. Notably, moderate physical and cold stimulation may indirectly enhance the oral self-cleaning potential by promoting local blood flow and glandular function. This nursing concept shifts from "passive removal" to "active creation," which is crucial for maintaining long-term oral ecological balance in such patients [3].

The observed trend of improvement in consciousness opens up new perspectives for clinical care of coma patients. Although changes in consciousness levels are influenced by multiple factors and the observation period in this study was relatively short, the more favorable trend observed in the intervention group warrants further exploration [4]. Existing neurophysiological knowledge indicates that rich sensory signals from the oropharynx are important inputs for maintaining the activity of the brainstem arousal system. The cold stimulation and passive joint movements included in the approach provide regular, non-injurious inputs to relevant sensory pathways. This input may function similarly to a gentle "neural awakening," helping to maintain the basic activity of neural pathways and avoid neural function degradation due to prolonged lack of external stimulation, thereby laying a better physiological foundation for consciousness recovery [5].

5. Conclusion

In summary, the combined oral care and swallowing stimulation approach developed in this study for patients with cerebral hemorrhage-induced coma is a standardized intervention program that integrates infection prevention and control, functional maintenance, and neuro-promotion concepts. Preliminary clinical validation indicates that this approach can effectively reduce the incidence of aspiration pneumonia, significantly improve the oral environment health status of patients, and exhibit potential positive effects on the consciousness recovery process. The approach is both scientifically grounded and operationally feasible, contributing new ideas to nursing practice in the field of neurocritical care and deserving further validation and application promotion in broader clinical settings.

Disclosure statement

The authors declare no conflict of interest.

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