

Nutritional Support under the Neuman Systems Model for Stroke Patients

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Abstract

Objective: To explore nutritional support under the Neuman systems model in treating dysphagia in stroke patients. **Methods:** In this retrospective study, we enrolled 97 patients with dysphagia after stroke admitted to our hospital, and randomly divided them into the Neuman group (n = 51) given nursing intervention based on Neuman systems model and a control group (n = 46) given routine nursing intervention. Both groups received nutritional support for 3 months. Nutritional indexes (serum total protein, plasma albumin, serum albumin, hemoglobin and transferrin levels) and immune indexes (immunoglobulin (Ig) A, IgG, IgM and total lymphocyte count (TLC) in both groups were recorded and compared. Pulmonary function recovery, video fluoroscopic swallowing study score, water swallowing test score, complication rate, and health knowledge mastery level were also compared between the two groups. **Results:** After the intervention, the Neuman group showed less decrease in the nutritional and immune index scores (serum total protein, plasma albumin, hemoglobin, serum albumin; IgA, IgG, IgM, and TLC; all $P < 0.001$). The scores of triacylglycerol, pulmonary function, and video fluoroscopic swallowing study were significantly higher ($P < 0.001$), while water swallowing test score was markedly lower in the Neuman group than in the control group ($P < 0.001$). Additionally, the total rate of complications such as abdominal distension, diarrhea, gastric tube reflux, aspiration pneumonia, urinary tract infection, malnutrition, and dehydration was significantly lower ($P < 0.05$), while the mastery scores of health knowledge (pathogenesis, healthy diet, rehabilitation training, complication prevention, emergency treatment) were significantly higher in the Neuman group than in the control group ($P < 0.001$). **Conclusion:** For patients with stroke and dysphagia, comprehensive nursing intervention (e.g., nutritional support) under the

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Neuman systems model can promote the recovery of immune, swallowing, and pulmonary function, reduce complication incidence and facilitate comprehensive rehabilitation, ensuring adequate nutritional intake.

Keywords

Stroke, Dysphagia, Neuman Systems Model, Nutritional Support, Pulmonary Function

1. Introduction

Stroke is a neurologic deficit disease caused by abnormal cerebral blood circulation, which commonly occurs in middle-aged and elderly individuals, and its disability rate can be as high as 80% [1]. Also, the incidence of dysphagia occurred in the acute phase of stroke can be 13% to 94%. This may be due to corticobulbar tract injury, for instance, bilateral injury of corticonuclear tract easily results in impairments of mastication, swallowing, and pronunciation [2]. For a long time, these conditions tend to reduce body tolerance and pulmonary function, further presenting as difficulty in exhalation, malnutrition, and aspiration pneumonia. Also, by disrupting the intestinal microecological balance of patients, the long-term conditions can lead to imbalanced immune function (presented as insufficient immunoglobulin production), and destroy the body's important lines of defense against bacteria and viruses [3]. Clinically, a nasogastric tube is usually inserted for enteral nutrition support to avoid nutritional imbalance. Nutritional support can help protect the homeostasis of intestinal flora and intestinal mucosal barrier function, which improves the nutritional status and immune capacity of patients [4]. Modern medicine advocates swallowing training in combination with nutritional supply to promote recovery of swallowing and pulmonary function [5].

However, routine nursing during hospitalization is generally aimed at disease signs, with a lack of systematic training on gag reflex, and lower jaw, etc., and unsatisfactory rehabilitation outcome. Conventional care is severely affected by environmental change and human impact, so that it cannot meet the multi-needs of patients [6].

Early nutritional support and comprehensive, scientific and systematic nursing intervention can regulate nutritional and immune status, reduce related complications (e.g., malnutrition), and promote pulmonary function in patients with stroke and dysphagia [7]. The Neuman systems model includes three aspects: people, stressor, and response. When people face stress, a series of responses is produced. In response to these responses, purposeful and targeted nursing interventions are used to reduce or avoid stress factors and adverse conditions affecting the optimal functional status of patients. This is to help them obtain and maintain the highest possible level of health [8]. At the same time, if Neuman's health care system is applied to clinical surgery, a comprehensive and

open nursing program can be developed according to the specific postoperative condition of patients [9]. However, as far as we know, there are no reports on the application of a Neuman systems model in nutritional support for patients with stroke and dysphagia. Based on the above findings, we investigated nutritional support under a Neuman systems model for treating these patients, so as to provide guidance for clinical nursing.

2. Materials and Methods

2.1. General Data

A retrospective study was conducted on 97 dysphagia patients after ischemic stroke who were admitted to our hospital from May 2022 and May 2023. All the patients were divided into the Neuman group (n = 51) given nursing intervention based on Neuman systems model and the control group (n = 46) given conventional care according to random number table method. Both groups received nutritional support. This study was approved by the Medical Ethics Committee of Qijing First People's Hospital (2022-007 (Ke)-01). Human data were performed in accordance with the Declaration of Helsinki. All patients and their families were informed of the whole course and signed an informed consent.

Inclusion and exclusion criteria: Patients were included if they were diagnosed with stroke according to the criteria from "Diagnostic Points of Various Cerebrovascular Diseases" revised by the Fourth National Academic Conference on Cerebrovascular Disease in 1995, and confirmed by head CT or MRI as a first-time stroke [10], were in clear consciousness and stable condition in the recovery period (2 weeks to 6 months from the onset); were confirmed with dysphagia by video fluoroscopic swallowing study score (VFSS); were classified as above grade III in water swallowing test (WST); had normal respiratory tract, and pharyngeal and laryngeal function without throat sensory impairment; can tolerate the nursing care for enteral nutrition through gastric tube. Patients were excluded if they were combined with severe heart, lung, kidney and other major organ dysfunctions; accompanied by blood diseases, mental diseases, craniocerebral malignant tumors or other organ tumors; had communication impairment, severe cognitive dysfunction, global aphasia, or mental diseases/history of mental diseases.

2.2. Methods

All the patients received basic treatment for stroke after admission. Moreover, the control group received in-hospital routine nursing, nasogastric nutrition supplementation, rehabilitation training, and education. On this basis, the Neuman group received nursing interventions under Neuman systems model for 3 months [11].

2.2.1. Nursing Evaluation and Diagnosis

The pressures faced by the patients after onset of the disease were classified into

loss of life and work ability, excessive economic and psychological pressure, and lack of nursing care. The perception of each patient was assessed by the responsible nurses and their changes were concerned. The specific condition, etiology, physical and mental status, nursing compliance and other characteristics were also taken into consideration to assess the key points of the intervention. In addition, possible complications were registered and archived at the bedside in a detailed and standardized way. By improving the external environment and ward infrastructure, the interference from external environment was reduced to a minimum, according to the specific stressors of patients (e.g., discomfort and resistance to the medical environment, depressed mood, and limited daily activities caused by swallowing or movement disorders). Then preventive interventions were developed based on the nursing diagnosis [11].

2.2.2. Preventive Care

1) Primary prevention

a) Knowledge and mental health education: First, a bedside education or electronic document was adopted to introduce relevant knowledge to patients and their families one by one from pathogenesis, etiology, nursing compliance, prevention of complications to the treatment of emergencies after discharge. Secondly, the emotional changes of such patients need attention before each nursing operation and timely emotional guidance should be given. This is due to the patients' long-term bed rest, inability to eat on their own, and depressed mood.

b) Personalized nutritional support: Patients were given 500 mL of enteral nutrition suspension (TPF) of Nutrison Fibre, (Nutricia Pharmaceutical (Wuxi) Co., Ltd., China; H200-30011, 500 mL (1.5 kcal/mL)), with standard nutrition intake of 25 kcal/(kg·D). On the first day of nutrition intake, 250 mL nutrient solution was given, and the nutrient solution supply was back to normal from the second day when there was no intestinal intolerance. If the patients developed infection and fever during treatment, an increase from the base value of 5 kcal/kg could be adopted for better nutrition intake, and the amount of nutritional support could also be adjusted appropriately according to the patients' other clinical manifestations.

c) Gastrointestinal care: The patient was turned and towed every 1 hour, and a turn-over card was applied with detailed record. During enteral nutrition support, the patients' physical condition was monitored, especially in terms of the patency of the feeding tube and the dripping speed of infusion to avoid nausea, diarrhea, gastric tube reflux, and other adverse reactions. The patients' physical conditions were monitored at all times, and a series of gastrointestinal decompression measures were also taken. If abnormalities occurred, the nurses immediately report them to the attending physician.

d) Respiratory function training: Posterior pharyngeal wall and the base of the tongue were gently touched with a cotton swab three times a day. At the same time, empty swallowing movements were performed to train the gag reflex (no less than 10 min each time). Abdominal breathing: Ballooning, blowing bubbles

and other means were applied to exercise the abdominal muscles, relax neck muscles, constrict breathing, and increase the ventilation (15 min/time, 3 times/d). The patients could blow up cheek, frown, grin, suck, exhale, etc. at any time every day to exercise the face and lower jaw. For patients with cheek weakness, nurses helped them massage and relax from the face to the mouth angle (15 min time was appropriate). Meanwhile, the patients were instructed to deliberately cough, or hold their breath and then cough up, so that the respiratory foreign materials could also be smoothly discharged (a training of 2 times a day was suggested) [12].

2) Secondary prevention

On the basis of controlling the disease and ensuring comprehensive intervention services, the patients were instructed to strengthen self-management, and fully realize the necessity and importance of compliant behavior. It was important to focus on cultivating a disease self-care program. The nurses should mainly strengthen the education, psychology, diet and exercise guidance, supervise the patients to take their drugs regularly (for abnormal blood pressure, the patients can receive stable blood pressure treatment following the doctor's advice), and teach patients to identify signs of disease recurrence, treatment complications, and corresponding preventive measures.

3) Tertiary prevention

Discharge instructions: With home rehabilitation intervention as its core, the nurses encouraged patients to carry out more daily activities, such as dressing and undressing spontaneously, washing, eating, and maintaining training on respiratory function and limb movement. Home rehabilitation education for their families was conducted, including training on diet, rehabilitation, psychological status, and treatment of complications, so that the patients could understand their importance and cooperate.

2.3. Observation Indicators and Evaluation Criteria

2.3.1. Main Observation Indicators

1) Swallowing function recovery

Swallowing functional scores, *i.e.*, VFSS and WST scores, were assessed in both groups before and after 3 weeks of intervention by swallowing angiography [13]. There were 4 grades (0 - 3 points) in the oral and pharyngolaryngeal phases, and 5 grades in the esophageal phase (0 - 4 points each, 10 points in total), with higher scores indicating better swallowing function. Meanwhile, the time taken to drink 30 mL of warm water and the degree of choking cough were evaluated by WST before and after the intervention when the patients sat upright [14]. The results were divided into grades I to V as follows: 5 s for one swallow (grade I, 1 point); more than 5 s for two swallows with no choking cough (grade II, 2 points); more than 5 s for one swallow with choking cough (grade III, 3 points); more than 5 s for two swallows with choking cough (grade IV, 4 points); failure of drinking water within 10 s with persistent choking cough (grade V, 5 points).

2) Nutritional and immune recovery

Nutritional indexes (serum total protein (TP), plasma albumin (PA), serum albumin (Alb), hemoglobin (Hb) and transferrin (TF) levels) and immune indexes (immunoglobulin (Ig) A, IgG, IgM and total lymphocyte count (TLC)) were recorded and compared between the two groups. Before and after 3 weeks of the intervention, 5 mL of fasting venous blood sample from each patient was taken, and the serum was collected after centrifugation. The nutritional index levels were determined by chemiluminescence method, and the IgM and IgG levels as well as TLC were measured by the one-way agar diffusion method, using the kit manufactured by Shanghai Yihe Biological Technology Co., Ltd., China.

3) Recovery of pulmonary function

The forced vital capacity (FVC), forced expiratory volume in one second (FEV1), and peak expiratory flow (PEF) were measured and compared between the two groups. Power Breathe K-5 respiratory training system was used to evaluate pulmonary function before and after 3 weeks of intervention.

4) Complications

Abdominal distension, diarrhea, gastric tube reflux, aspiration pneumonia, urinary tract infection, malnutrition, dehydration, and other complications were assessed after 3 months of intervention. The total complication rate = (the total number of complications)/the total number of cases \times 100%.

2.3.2. Secondary Observation Metrics

Health knowledge mastery level: The self-made knowledge scoring scale related to dysphagia after stroke was used for evaluation [15]. The same group of nursing staff evaluated the mastery level before and after 3 months of intervention, and the total score of the scale was 100 points. The scale mainly includes mastery of 5 items (20 points each): pathogenesis, healthy diet, rehabilitation training, prevention of complications, and emergency treatment. The score was directly proportional to the knowledge mastery level.

2.4. Statistical Analysis

Data analyses were performed with the SPSS 21.0 software package (IBM). The measured data were expressed as mean \pm standard deviation ($\bar{x} \pm sd$). Independent sample t-test was adopted for the comparison between the two groups and the paired sample t-test was applied for the comparison before and after intervention within the same group. Chi-square test (χ^2 test) was used for comparison between the two groups as to enumerated data expressed as the percentage or case/percentage (n%). $P < 0.05$ was considered statistically different. Images were processed using Graph Pad Prism 7.

3. Results

3.1. Comparison of General Data

As shown in **Table 1**, there was no significant difference between the two groups ($P > 0.05$), suggesting that the two groups were comparable.

Table 1. Comparison of general data.

Item	Routine care group (n = 46)	Neuman group (n = 51)	χ^2/t	P
Gender (male/female)	26/20	28/23	0.026	0.873
Age (years)	61.6 ± 4.8	62.5 ± 5.1	0.892	0.375
Course of disease (years)	0.8 ± 0.2	0.8 ± 0.1	0.000	1.000
BMI (kg/m ²)	23.37 ± 2.28	23.67 ± 2.19	0.661	0.510
History of pneumonia (n)	4	3	0.286	0.593
Disease type (n)			0.005	0.947
Cerebral infarction	34	38		
Encephalorrhagia	12	13		
Primary caregivers			0.615	0.736
Spouse	29	31		
Children	15	19		
Others	2	1		
Lesion location			1.067	0.900
Cerebral hemisphere	20	22		
Brain stem	9	7		
Cerebellum	1	2		
Basal ganglion	13	15		
Diencephalon	3	5		
Complication				
Hypertension	24	27	0.006	0.940
Diabetes	6	8	0.137	0.712
Coronary heart disease	9	6	1.126	0.289
Others	5	7	0.182	0.670
Monthly household income (yuan)			0.778	0.678
<2000	21	23		
2000 - 3900	18	23		
Above 4000	7	5		

3.2. Comparison of Swallowing Function Recovery

Before the intervention, there was no significant difference in the swallowing functional scores between the two groups (all $P > 0.05$). After the intervention,

the swallowing function scores in both groups were improved compared to those before the intervention ($P < 0.05$). The VFSS score was significantly higher (9.12 ± 0.73 vs. 6.37 ± 0.51 , $P < 0.001$), and the WST score was lower in the Neuman group than in the control group (1.07 ± 0.32 vs. 1.32 ± 0.46 , $P < 0.01$). See **Figure 1**.

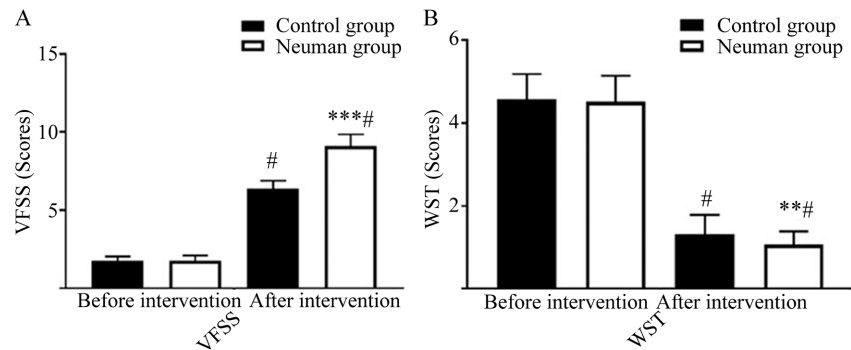


Figure 1. Comparison of swallowing function recovery. A: VFSS score; B: WST score. Compared with pre-intervention, # $P < 0.05$; compared with the control group, ** $P < 0.01$, *** $P < 0.001$. VFSS: video fluoroscopic swallowing study score; WST: water swallowing test.

3.3. Comparison of Nutritional Indexes before and after Intervention

Before the intervention, there was no significant difference in the nutritional indexes between the two groups (all $P > 0.05$). After the intervention, the TP, PA, Hb, Alb, TF levels of both groups were all decreased compared to those before the intervention (all $P < 0.05$). Furthermore, the Neuman group showed less decline than the control group (all $P < 0.05$). See **Table 2**.

Table 2. Comparison of nutritional indexes before and after intervention ($\bar{x} \pm sd$).

Item	Bfore intervention				After intervention			
	Control group (n = 46)	Neuman group (n = 51)	t	P	Control group (n = 46)	Neuman group (n = 51)	t	P
TP (g/L)	72.21 ± 8.52	73.27 ± 9.17	0.588	0.558	58.96 ± 6.24*	65.21 ± 7.52*	4.427	<0.001
PA (g/L)	237.46 ± 35.67	240.56 ± 42.57	0.386	0.700	180.35 ± 29.52*	211.46 ± 33.26*	4.850	<0.001
Alb (g/L)	41.67 ± 5.72	40.13 ± 5.87	1.306	0.195	32.67 ± 4.72*	36.72 ± 4.97*	4.104	<0.001
Hb (g/L)	124.57 ± 11.54	124.18 ± 13.72	0.151	0.881	107.53 ± 7.45*	119.31 ± 6.32*	8.422	<0.001
TF (g/L)	2.74 ± 0.64	2.79 ± 0.77	0.346	0.730	2.11 ± 0.35*	2.47 ± 0.48*	4.248	<0.001

Note: Compared with the pre-intervention, * $P < 0.05$. Total protein (TP), plasma albumin (PA), serum albumin (Alb), hemoglobin (Hb), and transferrin (TF) levels.

3.4. Comparison of Immune Indexes before and after Intervention

Before intervention, there was no significant difference in various immune indexes between the two groups (all $P > 0.05$). After intervention, TLC as well as IgA, IgG, and IgM levels in both groups were decreased compared with those before intervention (all $P < 0.05$); the decrease in the Neuman group was significantly less than that in the control group (all $P < 0.05$). See **Table 3**.

Table 3. Comparison of immune indexes before and after interventio.

Item	Before intervention				After intervention			
	Control group (n = 46)	Neuman group (n = 51)	t	P	Control group (n = 46)	Neuman group (n = 51)	t	P
TLC ($\times 10^9/L$)	2.27 \pm 0.62	2.31 \pm 0.58	0.328	0.743	1.46 \pm 0.51*	1.94 \pm 0.73*	3.783	<0.001
IgA (g/L)	2.79 \pm 0.83	2.80 \pm 0.94	0.055	0.956	1.83 \pm 0.47*	2.31 \pm 0.69*	4.037	<0.001
IgG (g/L)	11.27 \pm 0.65	11.29 \pm 0.72	0.143	0.887	8.76 \pm 0.34*	9.39 \pm 0.74*	5.473	<0.001
IgM (g/L)	1.74 \pm 0.32	1.75 \pm 0.36	0.144	0.886	1.45 \pm 0.27*	1.65 \pm 0.30*	3.437	<0.001

Note: Compared with the pre-intervention, * $P < 0.05$.

3.5. Comparison of Pulmonary Function before and after Intervention

Before the intervention, no significant difference was found in the pulmonary function indexes (FVC, FEV1, and PEF) between the two groups (all $P > 0.05$). After the intervention, the FVC, FEV1, and PEF of both groups increased compared with those before the intervention (all $P < 0.05$). Besides, the Neuman group revealed a greater increase in these index scores than the control group (all $P < 0.001$). See **Figure 2**.

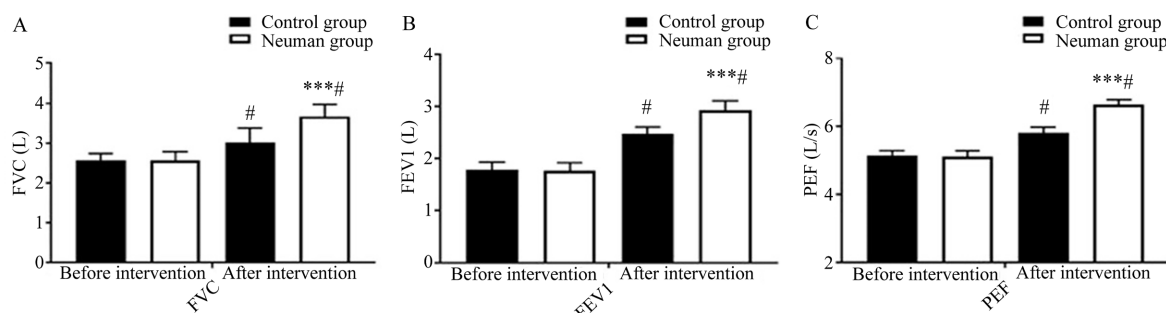


Figure 2. Comparison of pulmonary function before and after intervention. A: FVC; B: FEV1; C: PEF. Compared with pre-intervention, * $P < 0.05$; compared with the control group, *** $P < 0.001$. FVC: forced vital capacity; FEV1: forced expiratory volume in one second; PEF: peak expiratory flow.

3.6. Comparison of Complication Rate after Intervention

The incidence rate of complications such as abdominal distension and diarrhea, gastric reflux, aspiration pneumonia, urinary tract infection, malnutrition, and dehydration in the Neuman group was significantly lower than that of the control group (13.73% vs. 32.61%, $P < 0.05$). See **Table 4**.

3.7. Comparison of the Health Knowledge Mastery Level before and after Intervention

Before the intervention, no significant difference was identified regarding the health knowledge scores and total scores between the two groups (all $P > 0.05$). After the intervention, the scores of both groups increased compared to those before the intervention (all $P < 0.05$). Moreover, the health knowledge scores (pathogenesis, healthy diet, rehabilitation training, prevention of complications, emergency management) and total scores of the Neuman group were significantly higher than those of the control group (all $P < 0.001$). See **Table 5**.

Table 4. Comparison of complication rate after intervention (n, %).

Group	Abdominal distension/ diarrhea	Gastric tube reflux	Aspiration pneumonia	Urinary tract infection	Dystrophy	Dehydration	Overall complication rate (%)
Control group (n = 46)	6 (13.04)	2 (4.35)	1 (2.17)	2 (4.35)	2 (4.35)	2 (4.35)	15 (32.61)
Neuman group (n = 51)	3 (5.88)	1 (1.96)	0 (0.00)	1 (1.96)	1 (1.96)	1 (1.96)	7 (13.73)
χ^2	1.474	0.460	1.120	0.460	0.460	0.460	4.918
P	0.225	0.500	0.290	0.500	0.500	0.500	0.027

Table 5. Comparison of the health knowledge mastery level before and after intervention ($\bar{x} \pm sd$, point).

Item	Before intervention				After intervention			
	Control group (n = 46)	Neuman group (n = 51)	t	P	Control group (n = 46)	Neuman group (n = 51)	t	P
Pathogenesis	11.93 ± 1.56	11.67 ± 1.53	0.828	0.410	15.67 ± 2.13*	17.98 ± 2.73*	4.610	<0.001
Healthy diet	10.88 ± 1.63	11.05 ± 1.48	0.538	0.592	16.31 ± 2.87*	18.23 ± 2.07*	3.743	<0.001
Rehabilitation training	12.34 ± 1.82	12.09 ± 1.77	0.685	0.495	16.28 ± 2.21*	18.37 ± 2.56*	4.282	<0.001
Prevention of complications	12.51 ± 2.13	12.02 ± 2.11	1.137	0.258	16.19 ± 2.47*	18.75 ± 2.82*	4.733	<0.001
Emergency handling	11.35 ± 2.62	11.64 ± 2.28	0.583	0.561	16.52 ± 2.35*	18.46 ± 2.74*	3.723	<0.001
Total score	61.67 ± 5.34	62.38 ± 6.57	0.580	0.563	81.56 ± 6.23*	90.73 ± 7.29*	6.624	<0.001

Note: Compared with the pre-intervention, * $P < 0.05$.

4. Discussion

Clinical data reveal that malnutrition is common after stroke, which may be re-

lated to the mental confusion, anorexia and dysphagia (unable to eat spontaneously) of stroke patients. Thus, nutritional intake is affected and effective nutrition supply can't be ensured [16]. Studies have confirmed that one of the independent risk factors for poor prognosis in stroke is malnutrition [17]. Enteral nutrition support can promote the balance of nitrogen metabolism, and reduce the stress resulting from hyper metabolic reaction and dysfunction of digestive tract absorption, which allows for patients to achieve nutrition intake [18]. At the same time, how to conduct an effective nursing model and help patients quickly restore swallowing function is also essential during disease treatment and nutritional support [19].

Therefore, the nursing staff in our study was required to focus on the preventive care measures and provide nursing services from the physical, psychological, and mental aspects under the guidance of Neuman systems model. Our study demonstrated that the Neuman group show less decrease in nutritional indexes (TP, PA, Alb, Hb and TF levels) and immune indexes (immunoglobulin (Ig) A, IgG, and IgM levels as well as TLC) than the control group. The incidence of total complications such as abdominal distension, diarrhea, and gastric tube reflux was significantly lower in the Neuman group than in the control group. The results indicate that personalized nutritional support can ameliorate the nutritional status and immune function, and effectively reduce the complication rate. This is consistent with the study reported by Montoya *et al.* that a systematic intervention for inpatients could successfully improve patients' nutritional immune measurements (Hb, Alb, IgG, and IgM) [20]. This may be because gastric tube nutrition support can make nutrient absorption more comprehensive, and a Neuman systems model helps maintain the stability and focus on promoting the recovery of body's various indicators. Also, nutritional support can facilitate the balance of the internal environment and protect the structure and function of the intestinal mucosa. As enteral nutrient intake increases, protein decomposition is gradually inhibited to maintain the body's positive nitrogen balance, and stabilize nutritional status. With the satisfaction of nutritional needs, the nutritional indexes are significantly improved, and functional recovery is enhanced, especially immune recovery [21]. As to complications, enteral nutrition gradually restores the damaged gastric mucosa and the nutrients can stimulate gastric peristalsis and improve the protective effect of gastric mucosa. Nutrient solution components can reduce the damage to gastric mucosa by dilution of gastric acid, and regulate micronutrients and electrolytes so as to successfully reduce the gastric mucosal edema caused by electrolyte disturbance or other symptoms. Additionally, the components can reduce bacterial translocation of intestinal flora, thereby reducing the occurrence of infections [22].

Our study disclosed that the Neuman group had better pulmonary functions (FVC, FEV1, PEF) than the control group. Generally, dysphagia patients after stroke have weakened respiratory muscles due to impaired motor nerve pathways in the brain. The condition further results in decreased diaphragmatic con-

tractility and greatly reduced index levels of pulmonary function [23]. In addition, head tilt and thoracic kyphosis lead to inspiratory muscle weakness, shallow and rapid breathing, and aggravated dyspnea, thus decreasing FEV1 [24]. Hence, this study applied K5 respiratory training system by respiratory function training with a Neuman systems model as the guidance. First, maximum inspiration and expiration were performed at the maximum value to increase FVC. Second, patients slowly and naturally exhaled breath through the mouth until the gas was evacuated to increase FEV1. At the same time, the chest and shoulder muscles were relaxed for promoting expiratory muscle strength, and providing sufficient intrathoracic pressure as an assistance for cough, in order to increase PEF.

Cho *et al.* reported that bedside self-exercise is effective to enhance swallowing function in dysphagia patients after stroke [25]. Sproson *et al.* identified that rehabilitation training in swallowing is the best choice for facilitating swallowing function after stroke [26]. The Neuman group showed better VFSS and WST scores than the control group after the intervention. The results suggest that the gag reflex, jaw and larynx, cough, and breathing training in the Neuman group can effectively improve the flexibility of their lower jaw, larynx and gag reflex, while cough training can prevent disuse atrophy of respiratory muscles, increase alveolar ventilation, and clear respiratory secretions. Furthermore, respiratory training can also increase the strength of oral and lip muscles and ameliorate the movement disorder in the oral cavity of dysphagia patients. Respiratory function training can effectively stimulate respiratory muscles, and enhance muscle strength, airway response, reactivity, and clearance ability to foreign bodies. Also, it can strengthen the pressure in the oral and pharyngeal cavity, increasing the lifting range of the larynx, and the coordination between swallowing and respiratory muscles for more effective swallowing function [27]. In this study, the health knowledge mastery score of the Neuman group was significantly higher than that before the intervention and the control group, suggesting that one-to-one bedside education can significantly enrich the knowledge about the disease, and contributes to the self-care of patients after discharge and the smooth progress of the preventive care, and improves their nursing compliance. In this study, comprehensive nursing intervention was implemented for patients with dysphagia and stroke by identifying the patients' stressors under the core guidance of Neuman systems model. Ultimately, it helps improve the nutritional status and pulmonary function, and validly promote the recovery of patients' swallowing dysfunction. Inevitably, there are still some limitations in this study. This is a single-center study with small sample size; stroke patients are generally in severe condition, and tend to develop different degrees of sequelae, relapse or recur in the rehabilitation period. Whether the Neuman systems model has a long-term effect on their swallowing function as well as nutritional and immune status needs to be further explored. The follow-up time should be prolonged, and the sample size should be larger in the future. There are studies that develop mathematical models to predict the risk of stroke with age [28]. The study of

mathematical models predicting stroke risk suggests that under the Newman system model, a similar mathematical model can be developed to assess the individualized nutritional risks and rehabilitation needs of patients. There are also studies showing that botulinum toxin can improve severe dysphagia [29], which is an innovative treatment approach, and under the Newman system model, it is possible to explore combining such innovative treatments with nutritional support to improve patients' swallowing ability and nutrient intake, thereby promoting overall recovery.

In conclusion, nutrition support under a Neuman systems model can promote the recovery of immune, swallowing, and pulmonary function, reduce the incidence of complications, and promote comprehensive rehabilitation on the basis of ensuring adequate nutrition supply to patients with stroke and dysphagia. Based on this study, long-term follow-up studies can be carried out in the future to evaluate the impact of nursing measures such as nutritional support on the long-term quality of life of patients under the Newman system model, and how to develop personalized nutrition support programs according to the specific conditions of patients under the Newman system model can also be studied to more accurately meet the needs of different patients and improve the effect of nutritional support.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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