REVIEW ARTICLE

Research progress of clinical intervention and nursing for patients with post-stroke dysphagia

Wen-juan Fang[1] · Fei Zheng[1] · Lin-zhi Zhang[1] · Wen-hui Wang[1] · Cheng-chen Yu[1] · Juan Shao[1] · Yi-jin Wu[2]

Abstract

Post-stroke dysphagia (PSD) is a common and costly complication of stroke and is associated with increased mortality, morbidity, and hospitalization. Although most patients can spontaneously resume swallowing, there are still many patients who do not recover and even die. Despite multiple advances in the acute treatment and secondary prevention of stroke, the effective treatment of PSD remains a neglected area. Studies have shown that repair mechanisms of neurostimulation techniques and increased cortical activity play an important role in the treatment of PSD. In addition, nutritional interventions are also crucial for the treatment of malnutrition in PSD patients. Therefore, this article reviews the effects of the current main clinical treatment methods and nutritional interventions on the treatment and rehabilitation of PSD patients. It also emphasized the necessity of developing an individualized care plan for PSD patients, which is of great significance to promote the clinical treatment, nutritional status, prognosis, and quality of life of PSD patients.

Keywords Stroke · Dysphagia · Transcranial magnetic stimulation · Nutritional interventions · Rehabilitation

Introduction

Stroke is recognized as the leading cause of death and disability worldwide and is associated with multiple medical complications, resulting in prolonged hospitalization and high medical costs [1]. Among them, post-stroke dysphagia (PSD) is a common complication that affects many patients in the first hours and days after an attack and is associated with increased mortality and morbidity [2]. Globally, 15 million people suffer from stroke every year, of which up to 65% have swallowing problems [3]. Dysphagia is a swallowing disorder that can be divided into oropharyngeal dysphagia and esophageal dysphagia according to the different stages of swallowing. Oropharyngeal dysphagia is caused by oropharyngeal dysfunction or difficulty in perception during swallowing. It is usually a manifestation of systemic diseases rather than oropharyngeal-specific diseases [4]. Stroke is a typical cause of oropharyngeal dysphagia. Half of these

patients will recover within 2 weeks, and some require long-term feeding, which will seriously damage their function, recovery, and quality of life, and some will even die. Although dysphagia can be spontaneously improved in many stroke patients, 15% of patients still have swallowing problems 1 month after stroke [2]. Due to the high probability of dysphagia after stroke, it is necessary to evaluate the swallowing function and screen for dysphagia in stroke patients after admission. The assessment of dysphagia includes early preliminary screening (such as bedside dysphagia screening) and further instrumental assessment. The most commonly used instrumental assessments include fiberoptic endoscopic evaluation of swallowing (FEES) and video fluoroscopic swallowing study (VFSS), also known as modified barium swallow (MBS), which is the "gold standard" for the assessment of dysphagia [5, 6]. These facilitate the determination of the presence and severity of dysphagia in patients, the identification of patients requiring further instrumental evaluation, and the development of appropriate treatment plans.

The complications of dysphagia mainly include (1) the consequences of aspiration: pneumonia, repeated cough, and asphyxia; and (2) the consequences of changing diet and fluid intake: impaired nutrition and hydration, reduced quality of life, and social isolation. Pneumonia is a common complication of stroke, occurring in approximately 10% of hospitalized patients [7]. The incidence

✉ Yi-jin Wu
  yijinwu1224@163.com

1 Department of Neurology, The Second People's Hospital of Hefei, Heifei Hospital Affiliated to Anhui Medical University, Hefei, Anhui 230011, China

2 The Second Affiliated Hospital of Wannan Medical College, Wuhu 241000, Anhui, China

rate of pneumonia in elderly people, severe stroke, and PSD is probably as high as 40% [8]. The potential interaction of poor oral health, aspiration, and immunosuppression in determining susceptibility to pneumonia is currently considered [9]. Pneumonia is most commonly seen in the first week after stroke, which may be due to high incidence rate of dysphagia and acute immunosuppression. In a recent large retrospective study of stroke patients, the relative risk of in-hospital death in stroke patients with pneumonia was 5.7 (95% CI, 5.4–6.0) [10]. Although many advances have been made in the acute treatment (for example, thrombolysis, mechanical thrombectomy, hemicranectomy) and secondary prevention of stroke (for example, antithrombotic drugs, lowering blood pressure and lipid), the intervention of PSD is still a neglected research field. Furthermore, PSD-induced malnutrition, hydration, and poor quality of life have received less clinical and research attention than pneumonia. In a systematic review in 2009, patients with dysphagia had an increased risk of malnutrition, especially in the late acute stage [11]. At present, the effectiveness and practicability of available methods for assessing the nutritional status of stroke patients (for example, Demiquet index, anthropometry, hydration status) are unclear and need to be further evaluated. Therefore, further research on the pathogenesis, treatment, and future clinical care of PSD is of great significance for the treatment and rehabilitation of PSD patients.

Pathological mechanism of PSD

PSD is considered to result from damage to cortical and subcortical structures. Then, the cerebral cortex reorganizes, resulting in the recovery of swallowing. Researchers using transcranial magnetic stimulation (TMS) showed that the muscle tissue of the middle pharynx of the cerebral cortex in healthy volunteers was asymmetrically distributed on both sides [12]. Thus, stroke lesions affecting the "predominant swallowing hemisphere" may be responsible for dysphagia after unilateral hemisphere stroke [13]. In order to understand the mechanism of swallowing function recovery after stroke, video fluoroscopy (VFS) and TMS imaging over time were studied in 28 patients with hemispheric stroke. The results showed that the cortical map representation of the pharyngeal musculature in the undamaged hemisphere increased markedly in size in the PSD patients who recovered swallowing, but that there was no change in patients who had persistent dysphagia. The 1-month and 3-month TMS follow-up data showed that subjects with restored swallowing function performed more significantly in the pharynx of the unaffected hemisphere than at baseline. These findings suggest that reorganization of the contralateral hemisphere is critical for swallowing recovery [14].

Furthermore, a recent magnetic resonance imaging study of functional dysphagia in the cerebral hemisphere compared cortical activation during swallowing in stroke patients with dysphagia hemisphere and healthy subjects, supporting the theory that changes in the unaffected hemisphere are crucial to swallowing recovery [15]. Therefore, neuroplasticity may play an important role in the recovery of swallowing function [16]. In addition to the above neurophysiological changes, dysphagia also occurs when the level of consciousness decreases, which may be due to edema or delirium caused by large-area lesions of stroke. In this case, the size and location of stroke will be less important.

Treatment for PSD

The traditional treatment of PSD focuses on compensation and behavioral rehabilitation strategies, for example, speech therapy, which is one of the most important ways to treat this symptom. It can produce sensory and motor effects by stimulating the muscles related to swallowing, which can increase the motor ability and swallowing coordination of the laryngeal lift and pharyngeal muscles, and help restore the patient's language and swallowing function [17]. However, these treatments are patient-specific, and successful dysphagia treatment in one patient population does not necessarily produce the same results in another [18]. At the same time, with the continuous development of the understanding of spontaneous swallowing recovery after stroke, new treatments are being developed and implemented, and combined with traditional therapies to better manage and enhance swallowing recovery, which is also more conducive to the promotion of this combination therapy. In addition, malnutrition caused by PSD is closely related to increased mortality, prolonged hospitalization (thus increasing costs), inability to recover, and poor functional status. Malnutrition and dysphagia after stroke are risk factors for poor clinical outcomes [19]. Therefore, we mainly describe the current treatment methods for PSD patients from two aspects: clinical physical technology therapy and nutritional intervention therapy.

Clinical physical-technical intervention of PSD

At present, there are many methods for the clinical treatment of PSD, such as western medicine treatment and rehabilitation treatment, but the effect achieved after these treatment interventions is not ideal. Therefore, it is necessary to implement more effective intervention therapy for PSD patients. There was evidence that nerve repair mechanism and increased cortical activity play an important role

in the recovery of swallowing after stroke. Noninvasive nerve stimulation therapy has attracted special attention in the treatment of PSD. Nerve stimulation can promote cortical reorganization to accelerate the natural process of stroke recovery, which is characterized by peripheral or central stimulation, respectively [20]. Stimulation technology is expected to be implemented in the early stage after stroke, which is of great value in the treatment of PSD. But patients may not yet have language or cognitive impairments at this time, which may prevent following complex treatment instructions.

TMS

As early as about 30 years ago, Barker AT et al. had proved that the use of external magnetic stimulation can stimulate the nerve and brain at the same time [21]. Subsequently, TMS began to be used to study central motor conduction time in clinical neurology. Depending on the stimulation parameters, TMS can stimulate or inhibit the brain, allowing functional mapping of cortical regions and the generation of transient functional damage [22]. Compared with single pulse TMS, repetitive TMS (rTMS) can provide new insights into the pathophysiology of neural circuits and has been widely used in the field of motor and speech recovery [23]. TMS uses a copper coil placed on the scalp for magnetic stimulation, resulting in changes in electrical activity in the neocortex directly below the coil [24]. It is worth mentioning that Hamdy S et al. applied TMS to PSD for the first time, which was used to describe the physiological characteristics of cortisol pathway leading to swallowing muscle, and preliminarily explored the action mechanism of TMS on PSD treatment [12], which laid a theoretical foundation for the rehabilitation of PSD and promoted the further study of the plasticity and functional results of pharyngeal motor cortex.

Subsequently, a series of randomized controlled trials were conducted to further explore the effectiveness of TMS in PSD rehabilitation. The meta-analysis of Pisegna JM et al. and Liao X et al. showed that TMS of pharyngeal motor cortex combined with traditional dysphagia treatment was an effective method to improve swallowing function in PSD patients [24, 25]. TMS showed therapeutic effect 4 weeks after treatment, and high-frequency treatment (≥ 3 Hz) was more effective than low-frequency treatment (~ 1 Hz), and bilateral or contralateral stimulation may also had a positive effect on PSD, while ipsilateral stimulation had no effect [25]. It is suggested that the successful implementation of TMS as an intervention strategy will depend on a better understanding of the potential neuronal correlation of functional recovery. For a variety of reasons, TMS treatments have not been subjected to the kind of study that would precede the release of any new drug. There are no large clinical

trials and few systematic safety studies. Although, there are some studies devoted to safety that are extremely small and limited in scope. The most obvious and dangerous side effect of TMS is to induce seizures, which may be induced when subjects are exposed to prolonged high-frequency and high-intensity stimuli [26, 27]. In addition, some studies have found that TMS treatment has different effects on the hormone levels and mood of the subjects [28, 29]. Although there have been studies investigating the transient effects of TMS on various cognitive, perceptual, and motor functions, few have considered the longer lasting, unexpected effects of prolonged exposure. Therefore, high-intensity or long-duration training regimens offered in short periods of time should be avoided when there is no potential clinical benefit to the subject. At the same time, further large-scale and long-term systematic clinical and safety studies are still needed.

Pharyngeal electrical stimulation (PES)

PES passively stimulates the pharynx with low-amplitude electrical pulses. Using a transnasal catheter with electrodes in the pharyngeal region, PES is thought to increase brain activity in areas that control swallowing and promote cortical reorganization of the swallowing motor cortex [30]. In the early study of PES, effective stimulation parameters of 5 Hz, 10 min/day, and 3 consecutive days were established, and the intensity was determined by the patient's perceptual threshold plus 75% of the difference between the patient's maximum tolerance threshold and perceptual threshold [31]. These parameters have been used in recent studies to evaluate PES treatment in hemispheric stroke patients with dysphagia in the early subacute phase. Initially, these studies have bright prospects in improving dysphagia. Unfortunately, the above results could not be reproduced in recent studies, which showed that aspiration and clinical dysphagia did not improve significantly at 2 weeks and 3 months after treatment [32, 33].

Although the effectiveness of PES is inconclusive, other studies on the use of PES in stroke patients with tracheotomy and dysphagia have achieved positive results. PES improves dysphagia enough for most patients to extubate [34–36]. The effectiveness of PES may be related to the severity of stroke, and patients with more severe stroke showed better treatment response compared with patients with mild stroke [32, 34]. However, the long-term effect of PES on swallowing results, the relative effectiveness of active and passive PES, the optimal timing of PES treatment intervention, and the best stimulation parameters are still unclear. In addition, some studies have also suggested that PES can affect the nerve conduction pathway initiated by the swallowing function, thereby further aggravating the dysphagia in stroke patients.

This effect is a double-edged sword, and its pros and cons depend on the frequency of stimulation [37]. Therefore, the above research results suggest that PES has broad application prospects, and more evidence is needed to prove the mechanism of rehabilitation treatment in the future, as well as further research to determine the specific stimulation frequency, interval, and waveform to form the optimal plan.

Neuromuscular electrical stimulation (NMES)

NMES is a peripheral stimulation method in which transcutaneous electrodes deliver electrical current to produce muscle contractions in the suprahyoid or infrahyoid muscles [38]. Suprahyoid stimulation is considered to strengthen the strength of weak muscles to enhance hyoid pharyngeal complex and promote airway protection during swallowing, while subhyoid stimulation is considered to inhibit hyoid pharyngeal complex as a mechanism to resist swallowing [38]. NMES stimulates paralyzed nerve fibers and muscles through pulsed current, excites the swallowing higher center of the brain, and promotes the formation of new motor conduction pathways. At the same time, effective swallowing training can produce laryngeal elevation, which is conducive to protecting the airway and opening the upper esophageal sphincter during swallowing, so as to effectively improve dysphagia [39, 40].

It has been reported that the combination of traditional dysphagia therapy (TDT) and NMES can improve swallowing function and facilitate removal of feeding tubes in patients with severe PSD compared with TDT [41]. Studies have reported that in acute/subacute and chronic stroke patients, NMES therapy was more effective than no NMES therapy in improving swallowing function in the short term [38]. However, there is significant heterogeneity among studies, which is attributed to variability of stroke type, duration, intensity, stimulation frequency, and sample size [38]. Clinically, PSD patients may have different degrees of anxiety, fear, stress, and other negative impact disorders, which directly affect the recovery of swallowing function and increase the complexity of physical therapy [42]. Zeng Y et al. showed that NMES combined with conventional treatment can minimize the negative emotion of patients and greatly improve the compliance of patients with physical therapy [43]. However, the use of NMES for the treatment of dysphagia is controversial and is not covered by some medical insurance companies [44]. In addition, NMES introduces active current into biological tissue, and its intensity level is much higher than that of endogenous current, thus presenting potential risks to patient safety. It is reported that NMES is contraindicated in people with pacemakers (may affect the normal function of pacemakers, causing ventricular fibrillation), peripheral vascular disease, broken skin

(muscle contractions can cause the wound to open), pregnant women (can cause uterine contractions), malignant tumors, and so on [45]. Furthermore, the Food and Drug Administration had warned that if the electrodes are not placed properly (such as over the neck or mouth), severe spasms of the muscles of the throat and pharynx may occur, and even difficulty breathing [46]. Although NMES therapy combined with traditional PSD therapy has achieved some positive results in the treatment of dysphagia, the exact mechanism of NMES is not clear, and there is no consensus on the optimal placement of electrodes and the appropriate stimulation frequency and intensity. The use of NMES in treatment requires careful consideration of the specific swallowing defects of individual patients and a clear understanding of the target muscles.

Paired associative stimulation (PAS)

PAS is a peripheral and central nerve stimulation technology that can be implemented at the same time to induce the excitation of pharyngeal motor cortex [47]. The basic principle of PAS is based on the principle of Hebbian neural plasticity by providing stimulation at multiple sites. Hamdy S et al. tried to use PAS as a treatment for patients with PSD. When they paired PES with TMS, they found that PAS improved swallowing function in the short term, increased the excitability of the unaffected pharyngeal cortex, and decreased penetration-aspiration scores in chronic stroke patients [48, 49]. Moreover, they further determined that after repeated stimulation, patients who initially did not respond to PAS would also be induced to be excited, and the administration of PAS in a shorter time (~ 10 min) would lead to greater changes in cortical excitability compared with a longer time (~ 30 min) [48, 50]. Recently, Zhang C et al. reported that TMS and NMES were more effective in the treatment of PSD than NMES alone, while bilateral TMS and NMES were more effective in the treatment of PSD than unilateral stimulation [51]. However, the sample size of this study is very small, and these results need to be verified by larger studies.

There is no doubt that TMS, PES, NMES, and PAS have been used as powerful tools to study the neurophysiological mechanism of PSD. Similarly, these technologies will be regarded as effective methods for clinical rehabilitation doctors to deal with PSD in the future. In view of the limitations of relevant research, there are still some problems to be further studied: (1) although TMS is widely used in clinical and scientific research, more detailed comparison is still needed to deal with the therapeutic effects between these technologies; (2) more well-designed randomized controlled trials with larger sample size and long-term follow-up are needed; (3) in order to avoid selection bias as much

as possible, the target population of clinical trials should be more clear, and the enrollment of acute or chronic PSD should not be ambiguous.

Malnutrition in PSD patients

At present, most clinical studies focus on the application of physical technology or rehabilitation training to treat PSD, but other factors, such as the nutritional status of PSD patients, are a less explored topic. Nutritional support is essential for the treatment of PSD, as up to half of PSD patients are considered malnourished. In addition, dysphagia also brings difficulties in replenishing water and nutrition to stroke patients. Patients with mild to moderate dysphagia may be put on a "dysphagia diet," which includes thickened liquids and smooth-textured foods [52], while those with severe dysphagia may require tube feeding. At the same time, McGrail A and Kelchner LN found that hospitalized stroke patients receiving dilute fluid consumed more fluid than those receiving concentrated fluid, although the vast majority of people in both groups did not meet the standard of 1500 mL/day [53]. Given the risk of aspiration and the tendency of patients with dysphagia to resist thickened fluids, it is challenging to provide essential nutrition for patients with PSD. In a retrospective study of 261 stroke patients (including non-dysphagia patients with normal diet, mild dysphagia patients with dysphagia diet, and severe dysphagia patients with tube feeding), Kim S and Byeon Y found that the PSD patient group was malnourished according to their albumin and protein levels [54]. In addition, in the rehabilitation stage of PSD patients, patients with impaired balance control or participating in related activities need more energy to perform motor activities [55, 56]. It is observed that the resting energy expenditure (REE) of stroke patients increases [57], and the inability to meet daily energy needs may lead to negative energy balance.

Screening and assessment of nutritional risk

At present, nutrition management mainly includes nutrition screening, nutrition assessment, and nutrition intervention. Patients must undergo nutritional screening within 10 days of admission to assess whether the patient is at risk of malnutrition, so as to provide early nutritional support to the patient [58]. Common nutritional risk screening tools include (1) nutritional risk screening tool 2002 (NRS-2002): it has incomparable advantages over other tools in predicting nutritional risk and patients' nutritional treatment. It is recommended as the preferred tool for malnutrition risk assessment of inpatients [59]; (2) malnutrition universal screening tool (MUST): this tool has low correlation with outcomes

and can identify adults at low, moderate, and severe risk of malnutrition [60]. The European Society for Parenteral and Enteral Nutrition (ESPEN) uses subjective global assessment (SGA) and patient-generated subjective global assessment (PG-SGA) as nutritional assessment methods [61, 62]. If the patient is at nutritional risk, a professional should be invited to conduct a nutritional assessment, and a corresponding intervention plan should be formulated according to the specific situation. Commonly used evaluation indicators include anthropometric indicators and biochemical laboratory indicators [63].

Nutritional intervention of PSD

Calories and amino acids

Dysphagia in the early stage of stroke significantly affects the intake and utilization of nutrients in patients, which can easily lead to malnutrition and increase the risk of poor prognosis in stroke patients. Early and reasonable nutritional support for PSD patients is of great significance for preventing malnutrition and improving their quality of life. According to clinical evidence, calorie supplementation may benefit PSD patients by reversing higher energy consumption and negative energy balance caused by REE. For patients with malnutrition, intensive calorie supplementation can promote exercise recovery more than standard calorie supplementation [64]. Compared with the control group, the energy and protein intake of the supplement group increased significantly, and the mortality tended to decrease [19, 65]. At the same time, amino acid supplementation may also be an important factor in preventing the excessive catabolism of muscle protein after stroke. The combination of rehabilitation training and amino acid supplementation helps to improve the early muscle quality and functional efficiency of PSD patients [66]. In order to increase muscle protein synthesis and reduce muscle soreness, it is recommended to ingest leucine-rich amino acids after exercise, because leucine plays a crucial role in triggering postprandial muscle protein synthesis by regulating the mammalian target of rapamycin (mTOR) pathway [67].

Vitamins

In addition, studies have emphasized that a diet rich in fruits and vegetables may play a key role in the recovery of PSD patients [68, 69]. For patients with stroke prognosis, increasing vitamin intake can improve antioxidant capacity and increase functional recovery [70]. Aquilani R et al. discussed the supporting effect of antioxidant supplementation (vitamin C and vitamin E) on reducing oxidative damage.

At the same time, many studies have found that the levels of vitamin C and vitamin E in stroke patients were low, and the antioxidant capacity could be improved by increasing dietary intake of vitamin C and vitamin E, so as to reduce the levels of C-reactive protein (CRP) and plasma malondialdehyde, and achieve the therapeutic effect [70]. Other clinical evidence also supports that vitamin B and vitamin D could improve the recovery of stroke patients. Almeida OP et al. found that long-term use of vitamin B in the treatment of stroke patients played a positive role in reducing major depression and improving mental health [71]. Vitamin D deficiency is a common problem in stroke survivors and is associated with decreased muscle strength, balance, and physical function [72, 73]. Elderly hemiplegic stroke patients with low serum 25(OH)D concentration were more likely to have the risk of hip fracture. Vitamin D supplementation could reduce the risk of hip fracture by preventing the decrease of bone mineral density [74]. Although there is controversy regarding the effects of vitamin D supplementation on post-stroke recovery [75], most studies suggest its potential to support neurological function and enhance the recovery process.

Minerals

Supplementation of minerals (such as potassium and magnesium) is another important component of nutritional management. Studies had found that long-term delivery of potassium and magnesium to meet the dietary reference intake (DRI) could enhance the recovery of neurological function in stroke patients. Compared with the sodium salt group, the potassium/magnesium salt group showed significant improvement in neurological function. Interestingly, compared with the sodium salt group, the neurological function of the potassium salt group alone was not significantly improved [76]. Sahota P and Savitz SI emphasized that magnesium may affect many pathways, including increasing blood flow in ischemic brain areas and improving the recovery of cellular energy metabolism after ischemia. However, many preliminary studies and clinical trials supported the neuroprotective effect of magnesium to varying degrees [77].

In conclusion, supplementation of energy, vitamins, and minerals seems to significantly improve the rehabilitation of PSD patients. The most powerful evidence is that amino acids, vitamin C, vitamin E, potassium, and magnesium can promote patients' physical and mental health through nutritional intervention. These two aspects are important for quality of life and high rehabilitation efficiency. In addition, there was evidence that the behavioral characteristics of stroke patients could also affect a person's long-term adherence to dietary guidelines [78]. This may be helpful for the

neurosurgery and neurology department of the hospital to coordinate the long-term stroke counseling plan and evaluate the behavior pattern of patients, and increase patients' adherence to a healthy lifestyle.

The role of nurse and other multidisciplinary teams in the treatment of PSD

Nurse

For nurses, especially those in neurology, it is important to increase their understanding of PSD, because nurses often supervise patients while they eat, so they are often the first to observe patients with dysphagia. Therefore, nurses must understand the signs and symptoms of dysphagia so that they can take timely intervention measures. By early detection of dysphagia, nurses can help prevent complications, thereby reducing the number of PSD-related deaths.

Based on skilled observation techniques, nurses should observe the following signs and symptoms of PSD patients: (1) PSD patients may cough when eating or drinking water. This may be due to the weakness of the tongue, which causes food to fall from the root of the tongue into the unprotected airway, or due to delayed swallowing reflex, which causes food to enter the airway [79, 80]. Nurses should record whether the patient coughs during meals. However, the absence of a cough by itself does not mean that the patient is not inhaling food or fluids; (2) the food left in the mouth after swallowing is called bagging. Loss of oral sensation and hemiplegia of tongue on the affected side may lead to this symptom [80]. Nurses can assess whether food is pocketing by examining the patient's swallowed mouth; (3) facial hemiplegia caused by stroke can lead to ineffective oral control of food and fluids [79]. The assessment included a visual examination when the patient smiled, frowned, and puffed up his cheeks; (4) other factors that nurses should assess include weight, body temperature, and baseline and weekly measurements of food consumption. Any signs or symptoms of dysphagia must be reported to a physician immediately so that evaluation, diagnosis, and therapeutic intervention can begin immediately. Delayed intervention increases the risk of dysphagia-related complications in patients.

Therefore, nurses play a vital role in the treatment of PSD patients. On the one hand, as an advocate, when the nurse observes that the patient has signs and symptoms of dysphagia, she needs to take immediate action. The nurse should inform the patient's doctor directly and advocate immediate swallowing assessment. On the other hand, as an educator, nurses should begin educating patients and their families about dysphagia when dysphagia is diagnosed. Careful explanation of what is being done and why can help reduce fear and anxiety, and enhance cooperation and success for

patients and their families. It also includes information on the nature of the swallowing disorder, necessary dietary modifications, signs and symptoms of dysphagia and aspiration, interventions to promote efficient swallowing, and treatment of obstruction caused by a foreign body. Thorough dysphagia education can help patients and their families adjust to necessary changes in diet.

Moreover, increased awareness of dysphagia and its complications will help nurses prepare for the evaluation of high-risk patients, advocate timely diagnosis, use compensatory interventions, and educate patients and their families. Nurses who are good at assessing dysphagia can quickly refer to members of the interdisciplinary team and use nursing principles that can reduce or prevent related complications. At the same time, the personalized nursing plan for patients with dysphagia also needs the input of the whole interdisciplinary team, which is of great significance to the clinical evaluation, diagnosis, treatment, and related nursing of PSD patients.

Other multidisciplinary teams

The treatment and management of PSD is a multidisciplinary process. In addition to nurses, there are many other disciplinary teams involved, mainly including (1) speech therapists, who are mainly responsible for clinical bedside assessment of patients' swallowing function, develop a plan for swallowing disorder management with the help of other team members, complete swallowing assessments of radiological and fiberoptic endoscopic, and analyze and interpret the results [81]; (2) radiologists, who mainly operate video fluoroscopy to assess swallowing function and interpret video fluoroscopy findings with a speech therapist, and according to the examination results, together with the speech therapist, make treatment recommendations for the doctor [82]; (3) clinicians, who are mainly responsible for the diagnosis and treatment of patients' diseases, including drug treatment [83]; (4) physical therapists, who mainly assist patients to maintain the best posture and posture required for eating and swallowing, and assess whether patients need special chairs and cushions to ensure that patients can better maintain the posture required for eating and swallowing [84]; (5) the nutritionist, who can ensure that the patient has sufficient nutrition and water intake, and can meet the viscosity requirements of food and liquid formulated by the speech therapist, and make necessary adjustments to the patient's diet [85]; and (6) psychotherapists, who are mainly responsible for psychological evaluation, psychological support, and rehabilitation of patients, and to reduce the risk of suicide and self-injury in patients with severe anxiety and depression [86]. Therefore, both nurses and other multidisciplinary teams play a pivotal role in the entire treatment process of PSD patients. They work independently and cooperate with each other in all aspects of the treatment process. At the same time, they can further improve their own professional ability and accurately formulate individualized treatment plans for patients, which is of great significance for improving the treatment effect and quality of life of PSD patients.

Future outlook

With the rapid development of stroke diagnosis and treatment and the gradual change of the concept of rehabilitation, the clinical research on the treatment and rehabilitation of PSD patients is also increasing. Although this review presents a growing consensus on the effectiveness of neurostimulation, physical techniques, and nutritional interventions in enhancing dysphagia recovery, there are still many problems and uncertainties to be explored. In essence, the severity of stroke is influenced by a variety of factors, and due to the complexity of therapeutic interventions, it is difficult to determine exactly what leads to recovery [87]. The studies reviewed here included both acute and chronic PSD patients, who naturally recover at different rates, making it difficult to determine the effectiveness of clinical interventions. Furthermore, physical stimulation parameters and treatment time vary widely during actual interventions. In addition, many studies have used small samples or excluded patients with multiple strokes or complications that may lead to dysphagia. Therefore, they are not fully representative of the PSD population, and the results may not accurately represent their effectiveness. Another obstacle to implementing ideal clinical and nursing interventions in the current environment is the threat of coronavirus disease 2019 (COVID-19). Telemedicine for swallowing therapy is considered "safe and effective" [88]. However, this does not take into account the need for imaging assessment, especially in the acute phase of stroke, where the patient's status is in a state of flux. This also requires reference to the recent working group report of the Dysphagia Research Association and the international efforts of physical therapy to obtain best practice recommendations in the COVID-19 environment [89, 90]. As these studies are further improved and perfected to achieve the desired results, the treatment of PSD in the future will be very different from today, and this will happen sooner or later. This puts new demands on medical institutions because they need to be prepared for these changes and trained professionals can apply these new neurorehabilitation therapies. It also has further implications for the healthcare professionals involved in the care of these patients, as education on the diagnosis and management of dysphagia and its complications is a cornerstone in maximizing the possible recovery of stroke patients.

Declarations

Ethical approval None.

Informed consent All authors agree to the submission.

Conflict of interest The authors declare no competing interests.

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