

# Research Progress in Rehabilitation Nursing for Limb Dysfunction after Stroke

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**Abstract:** Stroke, as a highly prevalent cerebrovascular disease, often leads to limb dysfunction in patients, severely affecting their quality of life. Seeking effective rehabilitation nursing methods is of great significance for patient recovery. This article deeply analyzes various aspects such as intelligent rehabilitation technology, traditional Chinese medical therapies, Western medical therapies, and rehabilitation training methods. It explores the characteristics, effectiveness, and application prospects of various rehabilitation nursing approaches, providing a reference for clinical rehabilitation nursing of limb dysfunction after stroke, and helping to improve the quality of patient recovery and enhance their self-care ability and quality of life.

**Keywords:** Stroke; Limb dysfunction; Rehabilitation nursing

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## 1. Introduction

Stroke, as an acute cerebrovascular disease that seriously threatens human health, is characterized by high incidence, high disability rate, and high mortality rate. According to statistics, there are over 13 million new cases globally each year <sup>[1]</sup>. Due to China's large population base, unhealthy lifestyles, and aging population, it has become the country with the highest number of stroke cases in the world <sup>[2]</sup>. Motor dysfunction is the most common complication of stroke, with about 80% of patients experiencing hemiplegia or unilateral paralysis and half of these symptoms may persist for the rest of the patients' lives <sup>[3]</sup>. This not only causes great physical and psychological pain to the patients, severely limiting their self-care ability and significantly reducing their quality of life, but also imposes a heavy burden on families and society. Rehabilitation training plays a crucial role in the treatment of stroke patients, as it can effectively reduce functional disability, improve patient satisfaction with their own recovery, and accelerate the process of stroke rehabilitation <sup>[4]</sup>. With the continuous development of medical science and technology and the deepening of research on stroke rehabilitation nursing, various rehabilitation nursing methods have emerged, bringing new hope to patients with limb dysfunction after stroke.

## **2. Rehabilitation technology**

### **2.1. Intelligent rehabilitation technology**

#### **2.1.1. Wearable devices**

Wearable devices, with their portability and real-time monitoring capabilities, are gradually emerging in stroke rehabilitation nursing. These devices typically integrate multiple sensors, such as accelerometers and gyroscopes, which can accurately capture the movement information of patients' limbs, including the amplitude, speed, and frequency of movement. By analyzing these data, wearable devices serve a dual purpose. Firstly, they provide an objective assessment framework for rehabilitation therapists, enabling them to accurately track a patient's recovery progress and make timely adjustments to the rehabilitation plan.

Secondly, they offer real-time feedback to patients, enhancing their engagement and motivation during the rehabilitation process. For example, when the patient's limb movement reaches a preset goal, the device will emit a sound or vibration to give positive incentives to the patient, enhancing their enthusiasm and initiative in rehabilitation training. Wang *et al.* explored the guiding and monitoring role of the wearable device uCare in the rehabilitation of stroke patients<sup>[5]</sup>. The results showed that patients using this device had significant improvement in their ICF general set, dysfunction set, and brief core set for stroke compared to when they were enrolled. In the study by Si *et al.*, a wristband wearable device was used to monitor the number of target movements completed by stroke patients during daily activities<sup>[6]</sup>.

#### **2.1.2. Brain-computer interface technology based on motor imagery**

Brain-computer interface technology based on motor imagery is an emerging rehabilitation technique that utilizes specific brain signals generated by patients when they imagine limb movements. These signals are converted into control commands through computer algorithms, which then drive external devices to assist patients in performing limb movements. This technology not only stimulates the plasticity of the patient's brain and promotes the reconstruction of neurological functions but also provides a new rehabilitation pathway for patients who are unable to perform active movements due to limb movement disorders. Studies have indicated that providing patients with multimodal feedback, which integrates sensory information such as vision, hearing, and touch, may be more effective in improving motor function<sup>[7]</sup>. Sieghartsleitner *et al.* conducted 25 sessions of brain-computer interface training on 19 stroke patients, providing visual and proprioceptive feedback during signal matching. The results showed improvement in patients' motor dysfunction<sup>[8]</sup>.

#### **2.1.3. Virtual reality (VR)**

Virtual reality technology creates highly realistic virtual environments, providing patients with an immersive rehabilitation training experience. In VR rehabilitation training, patients can be placed in various virtual scenes, such as simulated daily life scenes (e.g., shopping, doing housework) and game scenes (e.g., ball games, flight games). By interacting with objects in the virtual environment, patients can complete various limb movement tasks. This training method is advantageous due to its strong interest and customizable tasks, effectively enhancing patients' training enthusiasm and participation. Additionally, the VR system can monitor patients' movement trajectories and task completions in real-time, providing detailed data feedback to rehabilitation therapists for adjusting training difficulty and programs. According to Karamians *et al.*, virtual reality-based games are more effective than traditional rehabilitation methods for upper limb recovery after stroke<sup>[9]</sup>. Other studies have pointed out that this technology significantly improves muscle strength, coordination, and flexibility when used for upper

limb rehabilitation <sup>[10]</sup>. Wu *et al.* also confirmed its remarkable effectiveness in improving upper limb function <sup>[11]</sup>. Evidently, virtual reality technology can serve as a method for rehabilitation simulation training.

#### **2.1.4. Rehabilitation robot-assisted therapy**

A rehabilitation robot is a device that can simulate human movements and provide precise movement training for patients. It can accurately control the intensity, speed, and mode of movements based on the patient's specific conditions, such as limb strength and range of motion, offering personalized rehabilitation training. Rehabilitation robot-assisted therapy has advantages such as high repeatability, precise movement accuracy, and good safety. It can effectively reduce the workload of rehabilitation therapists while ensuring the quality and effectiveness of training. Gu *et al.* selected 46 stroke patients with unilateral neglect within three months of onset <sup>[12]</sup>. All patients received conventional rehabilitation therapy, and on this basis, they underwent a nine-week upper limb rehabilitation robot training program. The results showed that upper limb rehabilitation robot-assisted therapy could effectively improve patients' unilateral neglect, upper limb motor function, and activities of daily living abilities.

### **3. Traditional chinese medicine therapies**

#### **3.1. Herbal medicine therapy**

Herbal medicine has a long history and rich experience in the rehabilitation treatment of limb dysfunction after stroke. According to Chinese medicine theory, limb dysfunction after stroke is often associated with factors such as Qi and blood deficiency, blood stasis, and meridian obstruction. Therefore, herbal medicine treatment often focuses on nourishing Qi and promoting blood circulation, clearing meridians, and resolving stasis.

Some classic herbal formulas, such as Buyang Huanwu Decoction, emphasize the use of Huangqi(Astragalus root) to tonify the Qi of the spleen and stomach, promote blood circulation, and eliminate stasis without injuring the healthy Qi. It is combined with Dangguiwei(Angelica root tail) to promote blood circulation and dredge meridians without injuring the blood. Chuanxiong(*Ligusticum chuanxiong*), Chishao(Red peony root), Taoren(Peach kernel), and Honghua(Safflower) work together with Dangguiwei to promote blood circulation and eliminate stasis, while Dilong(Earthworm) is used to dredge meridians and facilitate the circulation of medicinal effects throughout the body.

Studies by Wu *et al.* have shown that the modified Buyang Huanwu Decoction combined with acupuncture has a definite effect on patients with post-stroke limb dysfunction, reducing inflammation, promoting neurological recovery, and improving quality of life <sup>[13]</sup>. Zou Na *et al.* studied 60 patients with high muscle tension on the paralyzed side during stroke recovery and found that the combination of exercise therapy and herbal steaming significantly reduced muscle spasms and effectively improved upper limb joint function <sup>[14]</sup>.

#### **3.2. Acupuncture therapy**

Acupuncture is one of the important means of rehabilitation treatment in Chinese medicine. By stimulating specific acupoints, it activates the circulation of Qi and blood in the meridians, regulates organ functions, and thereby improves limb dysfunction. In stroke rehabilitation, commonly used acupoints include head acupoints(such as Baihui and Shenting) and limb acupoints(such as Jianyu, Quchi, Hegu, Huanqiao, Yanglingquan, and Zusanli). Acupuncture on head acupoints can regulate the function of the cerebral cortex and promote the recovery of

neurological function, while acupuncture on limb acupoints can dredge meridians, harmonize Qi and blood, and improve limb motor function. Different acupuncture techniques, such as lifting and thrusting, twisting and rotating, also have certain influences on the rehabilitation effect. Chen *et al.* studied 64 patients with post-stroke spastic paralysis and found that the combination of acupuncture and rehabilitation training, focusing on stimulating the motor and sensory areas of the head as well as the Yangming meridians of the affected hand and foot, significantly reduced muscle tension and improved rehabilitation outcomes compared to a single treatment approach <sup>[15]</sup>.

## **4. Western medicine therapies**

### **4.1. Drug therapy**

Drug therapy plays an important auxiliary role in the rehabilitation of limb dysfunction after stroke. Commonly used drugs include neurotrophic drugs and drugs that improve cerebral circulation. Neurotrophic drugs, such as Mecobalamin, participate in methyl conversion within nerve tissue and nucleic acid, protein, and lipid metabolism, promoting axonal transport function and regeneration, and repairing damaged nerve tissue, which can help improve limb dysfunction. Drugs that improve cerebral circulation, such as Butylphthalide, can improve microcirculation and blood flow in ischemic areas of the brain, increase the number of capillaries in ischemic areas, promote the establishment of collateral circulation, improve neurological deficit symptoms, and enhance patients' limb motor function and activities of daily living.

### **4.2. Exercise therapy**

Exercise therapy is one of the core components of stroke rehabilitation, mainly including Bobath technique, Brunnstrom technique, Rood technique, and PNF technique. The Bobath technique emphasizes the promotion of normal movement patterns by inhibiting abnormal movement patterns to improve limb function. The Brunnstrom technique, on the other hand, utilizes abnormal movement patterns such as associated reactions and common movements to guide patients to gradually restore normal movement based on different stages of motor function recovery after stroke. Pu divided 90 patients with post-stroke upper limb motor dysfunction into three groups: control group A received ordinary acupuncture, control group B received Brunnstrom graded acupuncture combined with exercise therapy, and the observation group received a combination of all these treatments plus transcranial magnetic stimulation for 4 weeks <sup>[16]</sup>. The results showed that the combined treatment had the best effect, significantly improving patients' motor and daily living abilities. The Rood technique stimulates receptors such as skin and muscles to induce or inhibit muscle contraction and promote the recovery of motor function. The PNF technique emphasizes the use of spiral diagonal movement patterns, stimulating the limbs through stretching and squeezing to enhance muscle strength and coordination.

### **4.3. Physical therapy**

Physical therapy includes various methods such as electrotherapy, phototherapy, magnetic therapy, and ultrasound therapy. Low-frequency electrical stimulation in electrotherapy can stimulate neuromuscular activity, causing muscle contraction, enhancing muscle strength, and improving limb motor function. Functional electrical stimulation (FES) can provide timely electrical stimulation to the corresponding muscles during limb movements, helping patients complete normal motor actions and promoting the recovery of neuromuscular function. Studies have shown that clinicians can provide functional electrical stimulation (FES) therapy for patients with reduced



lower limb motor function caused by acute or chronic hemiplegia after stroke, which can effectively optimize gait, increase walking speed, and enhance dynamic balance and other activities<sup>[17]</sup>.

#### **4.4. Psychotherapy**

Stroke patients often experience psychological issues such as anxiety and depression due to physical dysfunction, which can severely affect their rehabilitation enthusiasm and effectiveness. Therefore, psychotherapy plays a significant role in stroke rehabilitation nursing. Psychotherapy includes cognitive behavioral therapy, supportive psychotherapy, and relaxation training. Cognitive behavioral therapy helps patients identify and change unhealthy cognitive patterns and behavioral habits, enhances their understanding and coping abilities regarding the disease, and boosts their confidence in recovery. Zhang conducted a study on 110 stroke patients with cognitive dysfunction<sup>[18]</sup>. The results showed that the use of psychological and behavioral interventions not only significantly improved patients' cognitive function but also helped enhance their physical function. Additionally, supportive psychotherapy provides emotional support to patients through listening, comforting, and encouraging, alleviating their anxiety and depression. Relaxation training, such as deep breathing exercises and progressive muscle relaxation training, can help patients reduce physical tension and relieve psychological stress.

#### **4.5. Music therapy**

Music therapy is a treatment method that promotes patients' physical and mental recovery through listening to music and participating in music creation. In stroke rehabilitation nursing, music therapy can stimulate the brain's auditory center, activate neural pathways related to movement and emotion, and promote the recovery of neural function. Studies have explored motor abilities in music task training and the results showed that patients' speed, key pressure, and note accuracy improved rapidly during the first phase of training<sup>[19,20]</sup>. By the end of the second phase of training, functional enhancement and defect recovery were more prominent. Simultaneously, music has the functions of regulating emotions, relieving pain, reducing anxiety and depression, and improves patients' rehabilitation enthusiasm and compliance. Xu divided 100 stroke patients with hemiplegia into two groups for treatment<sup>[21]</sup>. One group received conventional rehabilitation training, while the other group received additional music therapy. After one month of assessment, both groups showed improvement in upper and lower limbs and overall scores, but the group with music therapy showed more significant improvement. This therapy also positively impacted patients' emotions and sleep.

### **5. Rehabilitation training methods**

#### **5.1. Group circuit training method**

The Circuit Training Method (CCT) is a rehabilitation therapy based on activity design. It provides patients with targeted, concentrated, and high-intensity rehabilitation exercise practices through group gatherings<sup>[22]</sup>. The advantage of this training method lies in its ability to fully utilize rehabilitation resources and improve training efficiency. Additionally, the mutual communication and encouragement among patients within the group can enhance patients' confidence and enthusiasm for recovery. The research results of Huang *et al.* show that task-oriented circuit training has a positive effect on patients' recovery<sup>[23]</sup>.

## 5.2. Mirror therapy (MT)

Mirror therapy is based on the plasticity principle of the brain. It utilizes the principle of mirror reflection to project the movement-image of the healthy limb onto the affected side, creating an illusion that the affected limb is moving. This induces cortical remodeling and improves the motor function of the affected limb. In clinical applications, patients are typically seated in front of a mirror with their affected limb hidden behind it while their healthy limb performs various movements in front of the mirror. By observing the movement of their healthy limb in the mirror, patients imagine that their affected limb is performing the same movements. Liu *et al.*'s research indicates that compared to the control group, the mirror group showed more significant improvement in lower limb motor function and activities of daily living<sup>[24]</sup>. Lee *et al.* used MT combined with afferent electrical stimulation to treat chronic stroke patients and found that compared to the control group, the experimental group showed significant improvement in muscle strength, modified Ashworth scale, Berg balance scale (BSS), gait speed, and step length<sup>[25]</sup>.

## 6. Conclusion and outlook

Significant progress has been made in the research of rehabilitation nursing for post-stroke limb dysfunction and various rehabilitation techniques, therapies, and training methods have continuously emerged, providing strong support for improving patients' quality of recovery. However, there are still some problems, such as the optimal combination and application timing of different rehabilitation methods, which are not fully clear. Additionally, the standardization and normalization of rehabilitation nursing need to be improved. In the future, greater emphasis should be placed on strengthening multidisciplinary collaboration, conducting large-scale, high-quality clinical studies, and thoroughly investigating the mechanisms and effectiveness of various rehabilitation nursing approaches. Additionally, developing more scientific, personalized, and evidence-based rehabilitation plans will be essential to improving recovery outcomes for patients with post-stroke limb dysfunction.

## Disclosure statement

The authors declare no conflict of interest.

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