



Post-Stroke Rehabilitation

U.S. DEPARTMENT OF HEALTH
AND HUMAN SERVICES
National Institutes of Health

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Introduction

Stroke is a medical emergency that requires immediate attention. In the United States, about 800,000 people each year suffer a stroke and approximately two-thirds of these individuals survive and require rehabilitation. The goals of rehabilitation are to optimize how the person functions after a stroke and the level of independence, and to achieve the best possible quality of life.

Advances in emergency stroke treatment can limit damage to the brain, which occurs either from bleeding into and around the brain (*hemorrhagic stroke*) or from lack of blood flow to a region where nerve cells are robbed of vital supplies of oxygen and nutrients and subsequently die (*ischemic stroke*).

The disability that a person with stroke experiences and the rehabilitation that is needed depends on the size of the brain injury and the particular brain circuits that are damaged. The brain has an intrinsic ability to rewire its circuits after a stroke, which leads to some degree of improved function over months to years.

Even though rehabilitation doesn't reverse brain damage, it can substantially help a stroke survivor achieve the best long-term outcome.

What is post-stroke rehabilitation?

Rehabilitation helps someone who has had a stroke relearn skills that are suddenly lost when part of the brain is damaged. Equally important in rehabilitation is to protect the individual from developing new medical problems, including pneumonia, urinary tract infections, injury due to fall, or a clot formation in large veins.

Research shows the most important element in any neurorehabilitation program is carefully directed, well-focused, repetitive practice—the same kind of practice used by all people when they learn a new skill, such as playing the piano or pitching a baseball. The neurorehabilitation program must be customized to practice those skills impaired due to the stroke, such as weakness, lack of coordination, problems walking, loss of sensation, problems with hand grasp, visual loss, or trouble speaking or understanding. Research using advance imaging technology shows that the functions previously located in the area of damage move to other brain regions and practice helps drive this rewiring of brain circuits (called neuroplasticity).

Rehabilitation also teaches new ways to compensate for any remaining disabilities. For example, one might need to learn how to bathe and dress using only one hand, or how to communicate effectively with assistive devices if the ability to use language has been affected.

What factors can affect the outcome of stroke rehabilitation?

- The severity and degree of damage to the brain.
- Age. The degree of recovery is often greater in children and young adults as compared to the elderly
- Level of alertness. Some strokes depress a person's ability to remain alert and follow instructions needed to engage in rehabilitation activities.
- The intensity of the rehabilitation program.
- Severity of concurrent medical problems.
- The home environment. Additions such as stair rails and grab bars can increase independence and safety at home.
- The work environment. Modifications to improve physical safety and modifications of work tasks may make return to work possible.
- Cooperation of family and friends. Supportive family and social networks can be a very important factor in rehabilitation, which usually extends over many months.
- Timing of the rehabilitation. Generally, the sooner it begins, the greater are the chances to regain lost skills and function and for a successful rehabilitation.

What disabilities can result from a stroke?

The types and degrees of disability that follow a stroke depend upon which area of the brain is damaged. Generally, stroke can cause five types of disabilities:

Paralysis or problems controlling movement (motor control)

Damage to cells and connections in the brain following a stroke can cause various problems with movement and sensation, including:

- Paralysis, loss of voluntary movement, or weakness that usually affects one side of the body, usually the side opposite to the side damaged by the stroke (such as the face, an arm, a leg, or the entire side of the body). Paralysis on one side of the body is called *hemiplegia*; weakness on one side is called *hemiparesis*.
- Problems swallowing (*dysphagia*)
- Loss of control of body movements, including problems with body posture, walking, and balance (*ataxia*)

Sensory disturbances, including pain

Several sensory disturbances can develop following a stroke, including:

- Losing the ability to feel touch, pain, temperature, or sense how the body is positioned. People who had a stroke also could lose the ability to recognize objects that they are holding or even their own limb.

- Pain, numbness, a feeling of heaviness in a limb, or odd sensations such as tingling or prickling in a paralyzed or weakened limb (called *paresthesia*). Numbness or tingling in a limb may continue even after recovering some movement.
- Loss of bladder and bowel control and loss of mobility to reach a toilet in time. Permanent incontinence after a stroke is uncommon.
- Chronic pain syndromes can occur as a result of mechanical problems caused by the weakness. Most often, the pain results from lack of movement in a joint that has been immobilized for a prolonged period of time (such as weakness or spasticity and the tendons and ligaments around the joint becoming fixed in one position). This is commonly called a “frozen” joint; treatment involves having a therapist or trained caregiver gently move or flex the joint to prevent painful “freezing” and to allow easy movement after voluntary motor strength returns.

More rarely pain can occur due to stroke-induced damage to the nervous system (neuropathic pain), the most common which is called “thalamic pain syndrome” (caused by a stroke to the thalamus, which processes sensory information from the body to the brain).

Problems using or understanding language (aphasia)

At least one-fourth of all stroke survivors experience language impairments, involving the ability to speak, write, and understand spoken and written language. In right-handed individuals these strokes usually involve the left side of the brain. A stroke-induced injury to any of the brain's language-control centers can severely impair verbal communication.

There are several types of aphasia:

- *expressive aphasia*, in which people lose the ability to speak or write the words they are thinking and to put words together in coherent, grammatically correct sentences.
- *receptive aphasia*, in which people have difficulty understanding spoken or written language and often have incoherent speech. Although these individuals can form grammatically correct sentences, their utterances are often devoid of meaning.
- *global aphasia*, in which people lose nearly all their linguistic abilities; they cannot understand language or use it to convey thought.

Problems with thinking and memory

Stroke can damage the parts of the brain responsible for memory, learning, and awareness. A stroke survivor may have a dramatically shortened attention span or may experience deficits in short-term memory. Some people also may lose the ability to make plans, comprehend meaning, learn new tasks,

or engage in other complex mental activities. Common deficits resulting from stroke are:

- *anosognosia*, an inability to acknowledge the reality of the physical impairments resulting from a stroke
- *neglect*, the loss of the ability to respond to objects or sensory stimuli located on the stroke-impaired side. This most commonly affects the left side of people with stroke on the right side of their brain.
- *apraxia*, the loss of ability to carry out a learned purposeful movement or to plan the steps involved in a complex task and act on them in the proper sequence. People with apraxia also may have problems following instructions.

Emotional disturbances

After a stroke someone might feel fear, anxiety, frustration, anger, sadness, and a sense of grief over physical and mental losses. Some emotional disturbances and personality changes are caused by the physical effects of brain damage. Clinical depression—a sense of hopelessness that disrupts the ability to function—is commonly experienced by stroke survivors. Post-stroke depression can be treated with antidepressant medications and psychological counseling.

When can a stroke patient begin rehabilitation?

Rehabilitative therapy typically begins in the acute-care hospital once the condition has stabilized, often within 48 hours after the stroke. The first steps often involve promoting independent movement to overcome any paralysis or weakness. A therapist will help with assisted or self-performed range of motion exercises to strengthen and increase mobility in stroke-impaired limbs. A stroke victim may need to learn how to sit up and move between the bed and a chair to standing and walking, with or without assistance. Beginning to reacquire the ability to carry out basic activities of daily living, such as bathing, dressing, and using a toilet, represents the first stage in the return to independence.

What medical professionals specialize in post-stroke rehabilitation?

The rehabilitation plan will change during the recovery process, depending on which part(s) of the body or abilities were affected and the type and severity of damage. A stroke rehabilitation team includes a variety of specialists:

- **Physicians** have the primary responsibility for managing and coordinating the long-term care of stroke survivors, including recommending which rehabilitation programs will best address individual needs. These doctors often include

physiatrists (specialists in physical medicine and rehabilitation), neurologists, internists, geriatricians (specialists in seniors), and family practice physicians. A physician also may recommend medicines to ease pain or treat a condition.

- **Rehabilitation nurses** can help a stroke victim relearn the skills needed to carry out the basic activities of daily living. They also provide information about routine health care, such as how to follow a medication schedule, how to care for the skin and manage bladder and bowel issues, how to move out of a bed and into a wheelchair, and special needs for people with diabetes.
- **Physical therapists** specialize in treating disabilities related to motor and sensory impairments. They help restore physical functioning by evaluating and treating problems with movement, balance, and coordination. A physical therapy program may include exercises to strengthen muscles, improve coordination, and regain range of motion; and constraint-induced therapy, in which an unaffected limb is immobilized, causing the person to use the affected limb to regain movement and function.
- **Occupational therapists** help to improve motor and sensory abilities while ensuring safety in the post-stroke period. They help a person relearn skills needed for performing self-directed activities (also called occupations) such as personal grooming, preparing meals, and housecleaning.

- **Therapeutic recreation specialists** help people with a variety of disabilities to develop and use their leisure time to enhance their health, independence, and quality of life.
- **Speech-language pathologists** help a person relearn how to use language or develop alternative means of communication and improve the ability to swallow. They teach problem-solving and social skills needed to cope with the aftereffects of a stroke.
- **Vocational therapists** perform many of the same functions that ordinary career counselors do, in helping people with residual disabilities identify vocational strengths and develop résumés that highlight those strengths. They also can help to identify potential employers, assist in specific job searches, and provide referrals to vocational rehabilitation agencies.
- **Social workers** can assist with making financial decisions and plan the return home or to a new living place. They also can help plan for care after being discharged from a rehabilitation facility.
- **Psychologists** can help with the person's mental and emotional health and assess cognitive skills.

Where can a stroke patient get rehabilitation?

Before discharged from the hospital, a stroke victim and family members will coordinate with hospital social workers to locate a suitable living arrangement. Many stroke survivors return home, but some move into a medical facility or other rehabilitation program.

- **Inpatient rehabilitation** units may be freestanding or part of larger hospital complexes. The stay at the facility for usually 2 to 3 weeks and involves a coordinated, intensive program of rehabilitation that may include at least 3 hours of active therapy a day, 5 or 6 days a week. Inpatient facilities offer a comprehensive range of medical services, including full-time physician supervision and access to the full range of therapists specializing in post-stroke rehabilitation and more specialized equipment.
- **Outpatient units** are often part of a larger hospital complex and provide access to physicians and also to the full range of therapists specializing in stroke rehabilitation. It may involve spending several hours, often 3 days each week, at the facility taking part in coordinated therapy sessions and returning home at night. Comprehensive outpatient facilities frequently offer treatment programs as intense as those of inpatient facilities, but they also can offer less demanding regimens, depending on the person's physical capacity.
- **Skilled nursing facilities** offer variable types of care and usually place a greater emphasis on rehabilitation, whereas traditional nursing homes emphasize residential care. In addition, fewer hours of therapy and fewer doctor visits are offered compared to inpatient rehabilitation units.

- **Home-based rehabilitation programs** allow for great flexibility to let a stroke victim and rehabilitation to tailor a program specific to that person's individual needs. Such a program allows the person to practice skills and develop compensatory strategies in the context of her/his own living environment. (However, there may not be access to specialized equipment found at a traditional rehabilitation facility.) Home-based rehabilitation may involve participating in an intensive level of therapy several hours per week or follow a less demanding regimen. Home-based rehabilitation programs are often best suited for people who require treatment by only one type of rehabilitation therapist. A recent stroke rehabilitation trial found that intensive balance and strength rehabilitation in the home was equivalent to treadmill training at a rehabilitation facility in improving walking.

What is the role of technologies in stroke rehabilitation?

Evidence about technologies for stroke rehabilitation is the fastest growing area of therapeutic research. As technology advances, innovative methods and devices will be used to guide new therapeutic approaches and augment existing ones. With the surge in technological advances over the past 10 years, the number of stroke rehabilitation randomized control trials has increased. The National Institutes of Health (NIH) has been at the forefront of increasing research on technology in rehabilitation

scenarios. Below are examples of how technology is being studied to play a role in the rehabilitation process:

- **Telerehabilitation:** a home-based telehealth system designed to improve motor recovery and patient education after stroke.
- **Transcranial Direct Current Stimulation for Post-stroke Motor Recovery:** A phase II study (TRANSPORT 2) aims to find out if brain stimulation at different dosage levels combined with an efficacy-proven rehabilitation therapy can improve arm function.
- **The Locomotor Experience Applied Post-Stroke (LEAPS)** trial found that people who had a stroke and had physical therapy at home improved their ability to walk just as well as those who were treated with a locomotor training program using treadmill walking with body weight support followed by walking practice. Study investigators also found that patients continued to improve up to one year after stroke.
- **The multi-site I-ACQUIRE** trial in infants with perinatal arterial stroke will determine the effectiveness of intensive infant rehabilitation to increase upper extremity skills.
- **Sleep-SMART (Sleep for Stroke Management and Recovery Trial)** will determine whether treatment of sleep-disordered breathing with positive airway pressure after acute ischemic stroke or high-risk transient ischemic attack prevents recurrent stroke, and whether treatment

of sleep-disordered breathing shortly after acute ischemic stroke improves stroke outcomes at 3 months.

How can someone help prevent another stroke?

About 200,000 strokes per year in the United States occur in people who have previously experienced one or more strokes. Stroke prevention is vital to stroke rehabilitation. Recent research has shown improvements in preventing another stroke through behavior modification combined with pharmaceutical interventions. Stroke survivors speak with their healthcare professionals about what types of supervised behavior modifications that can be made in order to decrease the effect these risk factors may have on overall health. Some of the most important treatable risk factors for stroke are:

- **Control high blood pressure** (hypertension). Hypertension is the most potent risk factor for stroke. Stroke survivors should work with their doctor to bring it down to the normal range. Changes may be needed to diet and/or to take prescribed medicines to help lower blood pressure.
- **Stop smoking.** Smoking greatly increases the risk of stroke and has been linked to the buildup of fatty substances in the arteries. It also raises blood pressure and makes blood thicker and more likely to clot.

- **Exercise regularly and maintain weight.** Obesity and inactivity are associated with hypertension, diabetes, and heart disease. Being overweight greatly increases the risk of ischemic stroke.
- **Lower cholesterol levels.** High cholesterol can lead to a buildup of fatty substances (atherosclerosis) in blood vessels, reducing the amount of blood and oxygen to the brain.
- **Check for heart disease.** Common heart disorders can result in blood clots that may break loose and block vessels in or leading to the brain. Medication may be needed to help prevent the formation of clots or surgery to clean out a clogged artery.
- **Manage diabetes.** Diabetes can cause destructive changes in blood vessels throughout the body, including the brain. Brain damage is usually more severe and extensive when the blood glucose level is high. Treating diabetes can delay the onset of complications that increase the risk of stroke.

What research is being done?

The National Institute of Neurological Disorders and Stroke (NINDS), a component of the National Institutes of Health (NIH), supports research on disorders of the brain and nervous system, including stroke and post-stroke rehabilitation. Several other NIH Institutes also support rehabilitation efforts. For example, the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development, through its National Center for Medical Rehabilitation Research, funds

work on mechanisms of restoration and repair after stroke, as well as development of new approaches to rehabilitation and evaluation of outcomes. Most of the NIH-funded work on diagnosis and treatment of dysphagia is through the National Institute on Deafness and Other Communication Disorders. The National Institute of Biomedical Imaging and Bioengineering collaborates with NINDS and NICHD in developing new instrumentation for stroke treatment and rehabilitation. The National Eye Institute funds work directed at restoration of vision and rehabilitation for individuals with impaired or low vision that may be due to vascular disease or stroke. More than 300 research projects have been funded by NIH since 2012 involving stroke rehabilitation.

More information about stroke rehabilitation research by NINDS and other NIH Institutes and Centers can be found using NIH RePORTER (<https://projectreporter.nih.gov>), a searchable database of current and past research projects supported by NIH and other federal agencies. RePORTER also includes links to publications and resources from these projects.

Research studies involving individuals with stroke and healthy individuals help researchers find better ways to safely detect, treat, and ultimately prevent stroke. Trials take place at medical centers across the United States and elsewhere. For information about NINDS-funded trials for people who have had a stroke, see www.clinicaltrials.gov and search for “post-stroke AND NINDS” as well as “stroke AND NINDS.”

NINDS supports research on ways to enhance repair and regeneration of the central nervous system. NINDS-funded scientists are studying how the brain responds to experience or adapts to injury to one section of the brain by having another part or parts take over and reorganize its functions (*neuroplasticity*)—using noninvasive imaging technologies to map patterns of biological activity inside the brain. Other NINDS-sponsored scientists are looking at brain reorganization after stroke and determining whether specific rehabilitative techniques, such as constraint-induced movement therapy and transcranial magnetic stimulation, can stimulate brain plasticity, thereby improving motor function and decreasing disability. Other scientists are experimenting with implantation of neural stem cells, to see if these cells may be able to replace the cells that died as a result of a stroke.

Given the burden of stroke and stroke rehabilitation to the U.S., NIH formed the NIH StrokeNet network (<https://nihstrokenet.org/>) to conduct clinical trials and research studies to advance acute stroke treatment, prevention, and recovery and rehabilitation. This network of 30 regional centers across the U.S., which involves more than 400 stroke hospitals nationally, is designed to move early phase ideas into the development of new potential treatments for people with stroke and those at risk for stroke. In addition, NIH StrokeNet provides an educational platform for stroke physicians, clinical trial coordinators, and stroke researchers.

Where can I go for more information?

For information on neurological disorders or research funded by the National Institute of Neurological Disorders and Stroke, contact the Institute's Brain Resources and Information Network (BRAIN) at:

BRAIN

P.O. Box 5081
Bethesda, MD 20824
800-352-9424
www.ninds.nih.gov

Information about stroke rehabilitation also is available from the following organizations:

American Stroke Association:

A Division of American Heart Association

7272 Greenville Avenue
Dallas, TX 75231-4596
888-478-7653
www.strokeassociation.org

***Eunice Kennedy Shriver* National Institute of Child Health and Human Development**

National Center for Medical
Rehabilitation Research
Information Resource Center
P.O. Box 3006
Rockville, MD 20847
800-370-2943
www.nichd.nih.gov

Department of Veterans Affairs

Resources & Education for Stroke Caregivers'
Understanding & Empowerment (RESCUE)
844-698-2311
<https://www.cidrr8.research.va.gov/rescue/index.cfm>



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