

Emerging Trends in Physical Therapy for Stroke Rehabilitation: A Comprehensive Review

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Abstract: A stroke, also known as a cerebrovascular accident (CVA), occurs when blood flow to a region of the brain is interrupted or when a blood vessel in the brain ruptures. Stroke is the fourth leading cause of death globally and a major cause of long-term disability. Few studies have examined the utilization of physical therapy techniques to prevent impairments and promote rehabilitation in stroke survivors. This review article synthesizes the latest advancements and innovative practices in stroke rehabilitation through physical therapy interventions. It critically examines the efficacy of various physical therapy techniques in enhancing the functional recovery of stroke survivors. By exploring the role of physical therapists in the multidisciplinary rehabilitation team, the article underscores the importance of personalized treatment plans and collaborative healthcare approaches. Additionally, it discusses the psychological support provided by therapists and the impact of new technologies in rehabilitation. This comprehensive analysis aims to guide practitioners and researchers in optimizing rehabilitation strategies for stroke patients.

Keywords: stroke, physical therapy, prognosis, recovery, rehabilitation

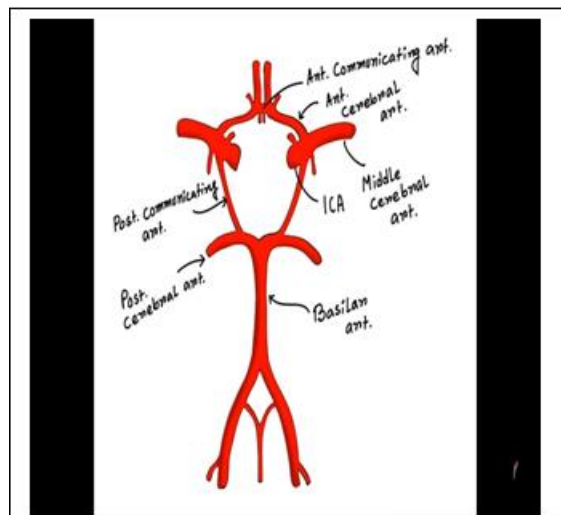
1. Introduction

A stroke occurs when the blood flow to a section of the brain is blocked or reduced, resulting in a lack of oxygen and essential nutrients reaching brain tissue. Brain cells begin to perish within minutes. Immediate medical attention is crucial in the case of a stroke, as early detection is vital in preventing brain damage and other detrimental outcomes. [1]

The positive news is that a significantly lower number of individuals in the United States are dying from strokes now compared to the past. Effective methods can also help avoid stroke impairments. [4]

Each year, stroke impacts around 800,000 persons in the United States. [7] Strokes can occur in two ways. In the first case, a blocked artery might prevent blood from reaching a specific part of the brain. Blood flows into or around brain tissue as a result. This type of stroke accounts for 85% of all strokes. [2] [3]

A blood vessel bursts or leaks, resulting in the second form of stroke. Blood flows into or around brain tissue as a result. This is known as a hemorrhagic stroke. Prompt treatment can help to prevent brain injury and death or disability. [2]



Etiology

Understanding the Fundamentals of Stroke: Stroke emerges when the blood supply to a specific part of the brain is disrupted. The brain cells begin to perish rapidly as they are deprived of essential oxygen and nutrients from the circulating blood.

Brief Explanation of Stroke Physiology: Cerebrovascular accident (CVA) or stroke is marked by the sudden appearance of neurological symptoms like partial paralysis, sensory irregularities, and speech difficulties (occurring within minutes to hours). A CVA is identified as any vascular injury leading to localized neurological dysfunction lasting more than 24 hours.

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Strokes are categorized into two primary types: ischemic strokes and hemorrhagic strokes, each having distinct effects on the brain and stemming from various causes.

a) Ischemic strokes

Blood clots that are caused by plaques (fatty deposits) in the arteries constrict or obstruct the flow of blood and oxygen to the brain causing the most common type of stroke. Atherosclerosis is the condition that causes these clots to form. While arteries naturally narrow with age, certain factors can speed up this process, such as smoking, obesity, high blood pressure (hypertension), high cholesterol levels, diabetes, and excessive alcohol intake. Another potential cause of ischemic stroke is atrial fibrillation, an abnormal heart rhythm that can lead to the formation of blood clots in the heart, which can then travel to the brain through blood vessels. [1] [3]

b) Hemorrhagic strokes

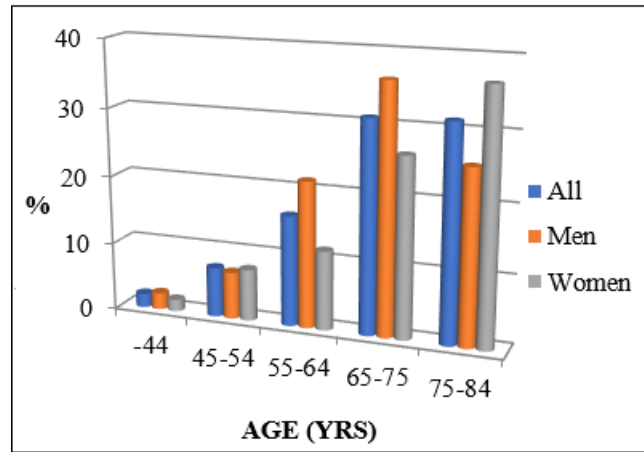
Ischemic strokes are more prevalent than hemorrhagic strokes, also known as cerebral or intracranial hemorrhages, which are less frequent. These occur when a blood vessel in the skull ruptures, leading to a leakage around or into the brain. The primary cause of hemorrhagic strokes is high blood pressure, as it weakens the brain's arteries, making them prone to splitting or bursting. Several factors contribute to elevated blood pressure, such as being overweight, excessive drinking, smoking, lack of physical activity, and stress. Additionally, the rupture of a blood vessel due to a balloon-like expansion (brain aneurysm) or poorly developed blood vessels within the brain can trigger hemorrhagic strokes. [1] [3]

The main reason for strokes in the United States is the blockage of this particular artery. Furthermore, the presence of leads to an increase in blood pressure; smoking produces carbon monoxide that restricts the amount of oxygen that your blood can transport to the brain; and cigarette smoke thickens the blood, making it more prone to clotting. [3]

c) Epidemiology

Strokes affect 15 million people worldwide each year. 5 million of these people die, and another 5 million are permanently disabled, putting an effect on families and communities. [6] Stroke is uncommon in adults under the age of 40, and the most prevalent cause is excessive blood pressure. Every year, around 795,000 people in the United States have a stroke, and 137,000 of these people die. Approximately 610,000 of these instances are first-time strokes, and 185,000 persons who survive a stroke will have another within 5 years.

The frequency of strokes noticeably increases as individuals grow older, doubling every ten years past the age of 55. On average, strokes happen at a rate of 30 to 120 cases per 100,000 people between the ages of 35 and 44 annually, and at a rate of 670 to 970 cases per 100,000 adults aged 65 to 74 each year. [6] [11]



Unclassified stroke, proportion of each age group

Stroke is caused mostly by high blood pressure, high cholesterol, smoking, obesity, and diabetes. One in every three adults in the United States has at least one of these conditions or habits.

2. Understanding CVA and Its Impact

1) CVA and its types

A stroke, also known as a cerebral vascular accident (CVA) or a brain invasion, is a disruption in the flow of blood to brain cells. When brain cells lose their supply of oxygen, they die. When an artery is blocked, blood flow to brain cells is interrupted, leading to a stroke. Alternatively, a stroke occurs when an artery ruptures, causing bleeding either inside or outside the brain. It is essential to understand that a stroke necessitates immediate emergency attention as much as a heart attack does. Every moment is critical for the victim's treatment, chances of survival, and future quality of life. [1] [3]

Frontal Lobe:

- Motor Function
- Prefrontal executive function
- Broca's Area (Speech)

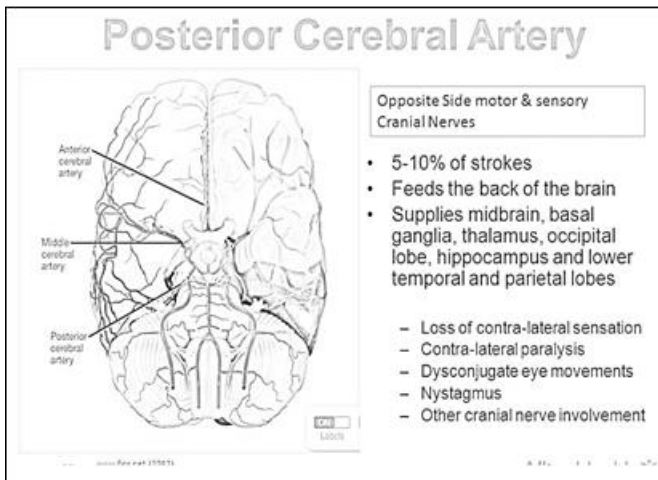
Parietal Lobe:

Somatosensory (sensations)
Spatial manipulation - Wernicke's Area (Language reception and comprehension)

Occipital Lobe: - Vision

Striate cortex

Temporal Lobe: - Auditory



- Basal Ganglia

MCA

- Frontal lobe
- Parietal Lobe
- Temporal Lobe
- Ant. The limb of the Internal capsule
- Basal Ganglia

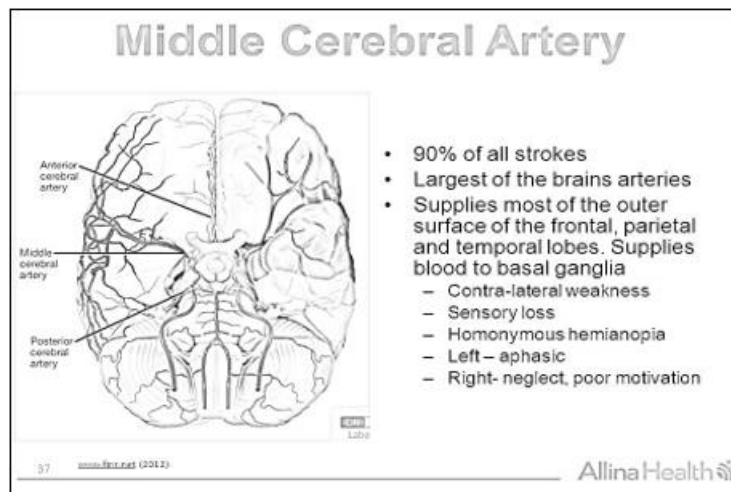
PCA

- Temporal Lobe
- Parieto - occipital Lobe
- Occipital Lobe
- Mid brain
- Thalamus

ACA

- Frontal lobe
- Parietal Lobe
- Internal capsule

Strokes can be separated into two types: ischemic strokes and hemorrhagic strokes. We discussed both types of CVA in the above data.



a) Immediate and long - term effects

A stroke can result in permanent disability. The long - term effects of a stroke are impacted by which part of the brain was affected and how severely it was damaged. Following a stroke, prompt medical attention and rehabilitation can enhance recovery and help many people regain a significant degree of function. The most common sorts of disability after a stroke are impaired speech, reduced physical abilities, weakness or paralysis of limbs on one side of the body, trouble gripping or grasping items, and a delayed ability to speak.

The long - term effects of a stroke are determined by which portion of the brain was affected and how severely it was damaged. Following a stroke, early treatment and rehabilitation can improve recovery and allow many patients to regain many abilities. Changes in speech, learning, and understanding, and weakness or paralysis on one side of the body are the most prevalent types of disability after a stroke. The healthcare providers who can assist you are determined by the nature of your problems. Speak with your doctor or rehabilitation team as a first step toward recovery after a stroke. [7]

b) Importance of Rehabilitation

The types of healthcare specialists who can assist you are determined by the difficulties you are experiencing. Consult your physician or the rehabilitation staff first; they can offer you immediate assistance or refer you to other medical professionals. Apart from your doctor, other healthcare providers who can assist you following a stroke include:

Occupational therapists, neuropsychologists, physiotherapists, rehabilitation nurses, psychiatrists, workers in social services, and Speech therapists.

Following a stroke, a person may only be able to dress or bathe using one arm or hand. If his ability to talk is impaired, he may also need to learn how to communicate effectively. The capacity to execute these daily activities is the first stage for stroke survivors to restore their independence. Experts in rehabilitation share that well - focused, carefully directed repetitive practice is an essential component of every rehabilitation program. [8]

Stroke rehabilitation programs may include the following components: [9]

Patient need	Example
ADLs, or activities of daily living, and self - care abilities	Feeding, grooming, bathing, clothing, toileting, and sexual function are all examples of bodily functions.
Mobility skills	Walking, transfers, and wheelchair use
Communication skills	Using words, writing, and other media to communicate
Cognitive skills	Memory, focus, decision - making, problem - solving, and organizational abilities
Socialization skills	Interacting with people at home and in the neighborhood clinic
Vocational training	Work - related skills
Pain management	Alternative pain management treatments and medications
Psychological testing	Identifying and solving difficulties with intellectual, behavioural, and emotional concerns
Family support	Help with adjusting to new lifestyles, financial issues, and discharge planning
Education	Education and training for patients and families on stroke, medical care, and adaptive strategies

Physical therapists are all educated and trained to handle a wide range of diseases and injuries. Consider the following: A physical therapist who has completed a residency or fellowship in neurologic physical therapy or who is a board - certified clinical specialist in neurology (called NCS). This therapist possesses extensive knowledge, expertise, and skills that may apply to your situation. A physical therapist with experience treating persons with stroke - related issues. Some physical therapists specialize in neurologic conditions. Physical therapists are members of the stroke recovery team. Physical rehabilitation usually begins while you are still in the hospital after a stroke. The primary goal of your physical therapist is to assist you in returning to your normal activities at home, at work, and in your community. Physical therapists treat stroke survivors by restoring movement and walking capacity, reducing disability, and improving function.

2) The Role of a Physical Therapist

a) Initial assessment and goal - setting

The evaluation process is essential for guiding stroke treatment. Your physical therapist will provide a complete evaluation that includes:

- Taking a medical history.
- In - depth discussion of your symptoms.
- Identifying risk factors for the illness.
- Examining lab results, X - rays, and other photos.
- Examining your capacity to move, stand, walk, and perform other activities.
- Conducting a hands - on physical examination.

Following an examination and evaluation of your condition, your physical therapist will create a treatment plan based on your individual needs, difficulties, and goals. They will collaborate with you to attain the highest possible quality of life. Your therapy strategy is going to focus on:

- Increasing your mobility.
- Take care of any pain you may be feeling.
- Advising on how to avoid difficulties that may arise after a stroke.

Your physical therapist will instruct you on the proper technique for transitioning from your bed to a chair and performing exercises while lying in bed. Throughout your recovery process, they will guide you in various strengthening exercises and practical activities to help restore your mobility. Later on, your physical therapist will:

- Assist you in improving your balance and walking ability.
- If necessary, fit you with a brace or a wheelchair.
- Give your family and caretakers training.

- Teach you how to use gadgets that can assist you in keeping mobile after a stroke has impaired your ability to move, walk, or maintain your balance. Orthoses, prostheses, canes, walkers, wheelchairs, and possibly robotics are examples of these.

Treatment for stroke patients varies. The results of your physical therapist's evaluation and the amount of time since your stroke will dictate the specific therapy you receive. The following factors influence stroke recovery:

- Your stroke size and position.
- How efficiently you were treated.
- The degree of brain damage present at the time of your stroke.
- Your other medical issues.

Your physical therapist will help you regain functional abilities that will enable you to participate in your daily activities. [13] [14]

b) Rehabilitation techniques

Your physical therapist will create an exercise and strengthening program based on the duties you must perform daily. Many approaches for stroke healing are being developed by physical therapist researchers.

• ROM Exercises for preventing contracture

ROM is typically measured during a physical therapy evaluation or treatment. Normal values vary according to body part and individual variance. The goal of ROM exercises is to avoid the development of adaptive muscle shortening, contractures, and capsule, ligament, and tendon shortening. [18]

One crucial step in the process of rehabilitating an injury involves restoring the range of motion in the affected joint. Before recommending various exercises to improve mobility, a thorough physical examination by a physiotherapist is necessary. This assessment takes into account the current range of motion and the quality of movement. Consistent stretching and use of the surrounding soft tissues are essential to keep joints flexible. Devoting 10 minutes three times a week to stretching can aid in enhancing the range of motion. In addition, it is common to include strengthening workouts following or in conjunction with a range of motion exercises. This is because enhanced joint movement without increased strength may lead to further harm. [12] [19]

- **Importance of gait training and balance exercises**

A stroke can impair a person's mobility and balance in a variety of ways. While a stroke normally affects one side of the body, other disabilities may potentially raise your risk of falling. Fortunately, stroke victims' balance skills can be regained with particular balance exercises and repetitive training. You may encourage the brain to reorganize itself and strengthen connections to weak muscle groups and motor pathways by practicing balance rehab activities. Gait training is a type of physical treatment used to enhance walking. It could be a component of a more extensive physical therapy program to treat a physical ailment or injury that makes it difficult or impossible to walk or walk correctly. Gait training is frequently recommended by doctors for persons who have an illness or condition that makes it difficult for them to walk on their own. [16] [20]

Gait has various advantages:

- Leg retraining and muscle memory development
- Increasing the strength of the afflicted muscles and joints
- Increasing balance
- Maintain good posture
- Increasing endurance
- Improving Mobility
- lowering the risk of a fall [21]

c) Techniques for improving muscle strength and coordination

You can begin practicing active stroke rehab activities once you have regained enough movement in your damaged muscles. The key difference between active and passive exercise is that active exercise involves voluntary muscular contractions. This signifies that your muscles are carrying out the activity on their own. The more you practice, the stronger the neurological systems that assist you in moving will develop. Your muscle power and control will eventually improve, increasing your efficiency with everyday tasks. To begin, move your affected arm or leg through the exercise without effort. As your abilities develop, you should advance to more difficult activities, such as weight - bearing workouts or resistance exercises.

This progressive loading stimulates muscle growth and may assist in the recovery from stroke atrophy. Additionally, your therapist may include a modality such as electrical stimulation into your active or passive workouts to help in muscle contraction. It is critical to understand that recovering muscular strength and control will require a significant number of repetitions. Work together with your therapy team to develop an exercise routine that you can stick to. Keeping yourself motivated and disciplined will help you gain strength and reverse muscular atrophy after a stroke. [19]

Many people suffer from balance and coordination problems after having a stroke. This could be due to a loss of strength, paralysis, or ataxia. Balance and coordination problems can occur with any stroke, although they are more likely when the stroke occurs in certain parts of the brain, such as the cerebellum and the temporal lobe. If the motor cortices are harmed, muscular strength and use may suffer, compromising balance and mobility. Following a stroke, it is critical to undergo balance and coordination exercises to help return to pre - stroke activities and safety. [11]

Treatment for coordination can be complex and can be heavily influenced by the severity of the impairment. The most effective coordination exercises are those that concentrate on:

- Achieving proximal stability (control near the body's centre)
- Weight - bearing and place - and - hold exercises
- Joint approximation (keeping the joint head in the capsule)
- Employing stable fixed joints Using vision to help with movement regulation

If a stroke survivor struggles to grasp and target objects with their arms due to coordination, eyesight can aid in coordinating their arm movement. A stroke's aftereffects can range from short - term memory loss to paralysis on one or both sides of the body, and they frequently impair one's ability to do ordinary routine tasks. Small movements should be practiced first, followed by greater ones to allow for motor learning. A doctor may also prescribe or propose surgical or pharmacological procedures to assist in alleviating tremors or in coordination.

Despite the availability of several community programs and private trainers, it is critical to convey all weaknesses and follow previously addressed physical therapy exercise plans for safety reasons. If it is deemed safe, simply getting out and walking might be one of the most effective activities for improving balance and coordination after a stroke. Following a stroke, internet - based seated chair yoga or other home fitness programs can also be beneficial, allowing for continuing involvement and progression of balance and coordination. [19]

3) Functional Improvement and Activities of Daily Living

Stroke rehabilitation encompasses a range of therapies designed to assist individuals in learning again the skills they may have lost due to a stroke. Rehabilitating a stroke victim can help with mobility, speech, strength, and other daily activities, depending on which parts of the brain are affected. Following a stroke, engaging in rehabilitation can contribute to restoring independence and enriching one's quality of life. There are many methods to assist people in recovering from a stroke. However, in general, rehabilitation is built on highly focused and repeated acts - doing the same thing over and over again. The area of your body or the type of ability that was impaired by your stroke will dictate your recovery plan. [22]

Physical activity may include the following:

- **Exercising your motor skills:** Exercise can assist enhance overall muscle strength and coordination. These can include balancing, walking, and even swallowing muscles.
- **Mobility practice:** You may be taught how to use mobility aids such as a walker, cane, wheelchair, or ankle brace. The ankle brace can help stabilize and strengthen your ankle so that it can support your body weight as you retrain to walk.
- **Therapy with constraints:** While you practice moving the damaged limb to help increase its function, an unaffected limb is restricted. This therapy is also known as forced - use therapy.

- **Therapy for range of motion:** Certain workouts and therapies can help you regain range of motion by reducing muscle tension (spasticity). [23] [24]

Adaptive devices can assist anyone with a disability in living freely. Adaptive devices (including a product, system, or machine) are used to assist people with disabilities or impairments in performing activities of daily living (ADL). Dressing and undressing, eating, maintaining continence, performing personal hygiene duties, and transferring and mobility actions are examples. Here are a few examples of adaptive devices: Canes, shower grab bars, and stair lifts are examples of mobility aids. Closed captioning, braille printers, and hearing aids are examples of cognitive and sensory aids. Motor aids include things like reach extenders, arthritic turners, key holders, and customized writing utensils. The Americans with Disabilities Act (ADA) protects disabled individuals from discrimination in many aspects of public life, including transportation, communications, access to government programs and services, and employment. [25]

Patients are typically given **home exercises** at their first physical therapy visit and are updated throughout care. They are given to reinforce what is done during each visit and, eventually, to help with the transition to self - management of the condition. The therapist checks these exercises for good form and advancement regularly throughout the course of treatment. [27]

There are various advantages to completing the home exercise plan given by their physical therapist regularly, including:

- Patients who complete their home exercises regularly are more likely to achieve more during their physical therapy sessions.
- A home fitness treatment might be the start of a new active lifestyle.
- Home activities that are done after discharge may help prevent the issue from recurring.
- Home exercises can result in long - term, positive habits.

4) Special PT Techniques

a) Exercises for Stroke Rehabilitation daily

While general exercise focuses on muscle strength, stroke rehabilitation exercise trains your brain to send messages to your muscles for action. Rehabilitation is based on activating neuroplasticity, the brain's mechanism for rewiring itself and learning new skills. [8]

- b) **Mirror Therapy for Hand Recovery** Mirror therapy is one successful way to activate hand - to - brain communication, particularly in patients with hand paralysis or extremely restricted hand movement. This technique may be beneficial in the management of post - stroke pain and the reduction of hemineglect, or the neglect of one side of the body following a stroke. [8] [15]
- c) **CIMT for Arm or Leg Paralysis** Constraint - induced movement therapy (CIMT) is a difficult type of physical treatment that can benefit stroke patients who have hemiplegia or hemiparesis. It works by limiting movement on the unaffected side while requiring usage of the affected side.

CIMT is frequently used as a rehabilitation strategy that starts in rehab and is subsequently continued at home. This technique might be difficult and irritating at times since actions with the affected limb may feel difficult or inefficient. However, this can be a great home therapy option for patients recovering from hemiparesis or hemiplegia. [8] [15]

Assistive Devices and Technologies for Stroke Patients

Assistive technology and devices play an essential role in supporting stroke patients on their way to recovery. Mobility aids, such as canes, walkers, or wheelchairs, enable people to regain their independence and movement by providing stability and assistance with daily activities. These devices allow for safer movement and assist in overcoming physical restrictions induced by the stroke.

These technologies allow targeted therapy, encourage movement, and involve patients in interactive and immersive rehabilitation exercises. Stroke patients can optimize their recovery, restore functional abilities, and improve their overall quality of life by using assistive equipment and technologies. [25]

A stroke can result in permanent disability. The long - term effects of a stroke are impacted by which part of the brain was affected and how severely it was damaged after a stroke, many people can improve their recovery and regain significant function with early treatment and rehabilitation. The most common sorts of disability after a stroke are impaired speech, reduced physical abilities, weakness or paralysis of limbs on one side of the body, trouble gripping or grasping items and a delayed ability to speak.

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5) Collaborative Approach

A wide range of specialists are involved in stroke rehabilitation.

Doctors: Neurologists, physical medicine and rehabilitation experts, and general care physicians can help to direct your care and avoid problems.

SLPs are speech and language pathologists: These specialists work with you to improve your language abilities and swallowing capacity. Speech and language pathologists can also help you build tools to help with memory, thinking, and communication issues.

Psychologists: These specialists evaluate your ability to think and assist you in addressing your mental and emotional health difficulties.

Specialists in therapeutic recreation: These professionals help you resume the pursuit of interests and responsibilities you had before your stroke, like hobbies and volunteer work.

The earlier you start stroke therapy, the more likely it is that you will regain lost abilities. Stroke rehabilitation may begin as soon as 24 to 48 hours after a stroke, while you are still in the hospital. While you're still in the hospital, you'll most likely begin stroke rehabilitation. You and your family will consult with hospital social workers and your care team before leaving to choose the appropriate rehabilitation environment for you. Consider your needs, what your insurance will cover, and what is most convenient for you and your family. It is important for interdisciplinary teamwork in CVA rehabilitation.

Physical therapists collaborate closely with other healthcare professionals, including occupational therapists, speech therapists, and physicians, to ensure that patients receive comprehensive and well-coordinated care. Through this teamwork, they share insights and information to deliver holistic rehabilitation for individuals who have survived strokes. This cooperative approach not only enhances the effectiveness of treatment but also facilitates a seamless transition from acute care to outpatient or home-based rehabilitation. By combining their specialized knowledge, physical therapy and other interventions contribute significantly to helping stroke survivors regain their mobility, independence, and overall quality of life. [18] [23] [15]

3. Conclusion

Physical therapy is essential for stroke recovery, aiding survivors in restoring mobility and overall functionality. Experts in this domain collaborate with survivors to assess their limitations and devise customized treatment plans. These plans may encompass diverse elements, including physical exercise, assistive tools, educational interventions, and skill-enhancing activities. Comprehensive physical therapy empowers stroke patients to significantly improve their stability, agility, muscle strength, stamina, and self-reliance. This form of therapy takes a comprehensive approach to patient care, addressing not only the physical but also the emotional and psychological aspects post-stroke. Notably, physical therapy significantly reduces the risk of complications such as muscle contraction, falls, and pressure ulcers. The unwavering contribution of physical therapists becomes indispensable in empowering stroke survivors with precision throughout their recovery journey.

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