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Stroke Rehabilitation: An In-Depth Guide

Introduction

Strokes are one of the most common and impactful neurological conditions that an individual can experience. As with many other conditions, occupational therapists can make a large difference in the world of stroke rehabilitation. One of the many ways that occupational therapists can help patients with a history of stroke is by helping change behaviors and habits to lessen the impact of modifiable risk factors. Therapists can also provide a range of therapeutic interventions that help people who have sustained strokes in rebuilding certain skills and regaining their independence. Occupational therapists work with a range of other healthcare professionals to provide multidisciplinary stroke rehabilitation at all points in the continuum of care. Stroke rehabilitation may look different across practice settings. But there is a substantial amount of evidence that supports occupational therapy for individuals who require rehabilitation after a stroke.

Section 1: Classifications and Prevalence [1,2,3,4]

Strokes are a major concern in the United States. Statistics show that strokes are the fifth most common cause of death among adults. While this high ranking makes them an imminent health concern, there are a growing number of advanced medical treatments and rapid care protocols that are contributing to a higher survival rate for stroke victims. This means there is an especially strong need for effective and evidence-based stroke rehabilitation programs to help a large number of people recuperate after this health event.

Each year, just under 800,000 people suffer from a stroke. Of this total, around 25% are people who have a prior history of stroke. Research also shows that strokes are particularly correlated with cardiovascular disease. Data from recent years cites stroke as the cause of death for 1 in every 6 people with heart conditions. Stroke has a large impact on this particular population, but its reach extends far beyond that.

Between 2014 and 2015, the cumulative cost of strokes (including medical treatment, worker's compensation resulting from missed employment, and prescription medications) in the United States totaled $46 billion. Across the board, stroke is one of the leading contributors to disability in America. While each person's clinical presentation differs based on the severity and type of stroke they sustained, over half of stroke survivors experience impaired mobility afterward. Strokes also have a notable

impact on a person's speech and cognition. These three factors together often leave stroke survivors with impaired safety following an event.

Strokes affect various races, ages, and ethnicities differently. Studies show that black individuals are almost twice as likely to experience a stroke for the first time when compared to those who are white. Latinx individuals are currently seeing the highest death rates as a result of stroke, and the prevalence within this group has been rising since 2013.

Age is another factor that may play a part in the occurrence of stroke. Older adults are at a greater risk for strokes, since someone's risk of this condition steadily increases as they age. However, younger people (especially those who have several risk factors) can also experience a stroke.

This data collectively encompasses all types of stroke. But stroke is an umbrella term that can be broken into four different classifications. All healthcare providers must understand each type of stroke since their presentation, treatment, and prognosis all differ. Strokes, also known as cerebrovascular accidents or CVAs, are the most common acquired brain injury. Unlike traumatic brain injuries where external sources (like a blow to the head or hitting your head on the ground) cause damage to the brain, acquired brain injuries are caused by internal concerns such as infection, oxygen loss, or disease.

There are four types of stroke: transient ischemic attack (TIA), ischemic stroke, hemorrhagic stroke, and arteriovenous malformation (AVM). TIAs and ischemic strokes occur as a result of a blood clot or blockage in blood vessel(s) within the brain. These blockages are also known as cerebral infarcts, which indicates that there has been the death of tissue in the cerebral cortex. In contrast, hemorrhagic strokes and AVMs are caused by the rupture of blood vessels. This rupture causes blood to accumulate in larger areas of the brain.

TIAs are referred to as mini strokes, since the related blockages are temporary and smaller than those associated with an ischemic stroke. Blockages that lead up to TIAs resolve on their own and blood flow is known to resume to the area within minutes or hours after the initial occlusion. While TIAs are known for not causing lasting deficits, they often resemble typical strokes. This means that anyone who experiences a TIA requires immediate medical attention to get a firm diagnosis and treatment. Time is of the essence, since TIAs are also considered a warning sign that places someone at risk for an ischemic stroke.

The presence of more permanent blockages in the brain is defined as an ischemic stroke. These blockages do not resolve on their own and prevent oxygen from getting to vital structures in the brain. Oxygen loss causes brain cells to die, and it does not take much oxygen loss to cause cell death. Tissue death in the brain will occur within minutes.

The category of hemorrhagic strokes (also known as cerebral hemorrhages or aneurysms) can be broken down into two types: intracranial hemorrhages and subarachnoid hemorrhages. When someone experiences an intracranial hemorrhage, bleeding occurs within the lobes of the brain. Subarachnoid hemorrhages are characterized by bleeding between the brain and the outer layers of membrane that surround it.

The last type of stroke differs quite a bit from the others. This is called an arteriovenous malformation, which indicates the presence of structures that place someone at risk for a stroke. When someone has an arteriovenous malformation, there are bundles or clusters of abnormally-formed blood vessels located in the spine or brain. These structures are usually present from the time of someone's birth and can be dormant for years without causing any concerns. However, when they rupture, it results in a hemorrhagic stroke that causes bleeding throughout the brain.

Section 1 Personal Reflection

Why do you think the prevalence of stroke is so high in the United States?

Section 1 Key Words

Acquired brain injury (ABI): An injury that causes damage to the brain as as result of an infection, oxygen loss, or another systemic condition

Arteriovenous malformation (AVM): A tangle of abnormal blood vessels found in the brain or spinal cord; they are present at birth and do not usually cause issues until they rupture, which leads to a hemorrhagic stroke

Cerebrovascular accident (CVA): The technical verbiage for stroke, which can be broken into four different types

Hemorrhagic stroke: A type of stroke that results from ruptured blood vessels; this type of stroke typically affects large parts of the brain since the blood travels

Infarct: The act of tissue dying off; this can occur in most any organ, but when it occurs in the brain, it's called a cerebral infarct; cerebral infarcts typically result from a ruptured blood vessels or blockages that cause oxygen loss

Intracranial hemorrhage: A bleed that occurs within various lobes of the brain

Ischemic stroke: A type of stroke that results from blockages or clots in the brain, which prevent oxygen and nutrients from traveling to brain cells

Subarachnoid hemorrhages: A bleed that occurs between the brain and its surrounding membranes

Transient ischemic attack (TIA): A small, temporary blockage that resolves without treatment shortly (within minutes or hours) after it first occurs; this is known as a mini stroke

Section 2: Neuroanatomy of the Brain [5,6,7,8,9,10,11,12]

While each type of stroke has different presentations that result in various symptoms, the same goes for the location of the stroke. Each brain lobe governs a different set of functions, as does each artery in the brain. The frontal lobe is the largest and is located just behind and across the forehead. The right hemisphere of the frontal lobe controls the left side of the body and the left hemisphere of the frontal lobe controls the right side of the body. This lobe is in charge of the higher-level functions that set humans apart from other mammals. The frontal lobe controls the following functions:

- Voluntary motor control
- Motor planning (initiation, sequencing, termination)
- Voluntary control of extraocular muscles (those that govern saccades and pursuits)
- Expressive language
- Motor control of speech
- Primary cognition
- Executive functioning (planning, organizing, initiating, self-monitoring, and impulse control)

- Judgment
- Memory
- Problem-solving
- Insight
- Personality and empathy
- Attention
- Emotion control
- Preferential judgment

Since the frontal lobe is large and has many functions, each part of the lobe is responsible for something different:

Area	Location within the Lobe	Function	Presentation After Injury

Primary Motor Area	Precentral Gyrus -
	
	Lateral and medial-superior
		• Responsible for voluntary initiation of movement
		• Directly controls fine motor movement in the upper extremities
			• Loss of voluntary control of contralateral movement
			• Presence of upper motor neuron signs
			  ○ Muscle weakness
			  ○ Decreased muscle control
			  ○ Fatigue
			  ○ Spasticity
			  ○ Exaggerated deep tendon reflexes

Premotor or Secondary Motor Area	Anterior to precentral gyrus	• Motor planning (initiation, sequence, termination) • Is linked with basal ganglia and cerebellum for control of motor learning	• Difficulty starting, sequencing, terminating tasks or actions • Apraxia • Dyspraxia • Perseveration

Supplementa l Motor Area	Medial frontal gyrus	• Motor planning in response to environmental stimulus • Helping create a new motor plan when one does not work	• Apraxia • Dyspraxia • Perseveration
Frontal Eye Field	Middle frontal gyrus - anterior to premotor area	• Voluntary control of extraocular muscles	• Impaired saccades and pursuits
Broca's Area (dominant side)	Inferior frontal gyrus	• Expressive language • Motor control of speech and gestures on the dominant side of the body • Grasping tone, accents, and speech patterns on the nondominant side of the body	• Expressive aphasia
Dorsolateral Prefrontal Cortex	Anterior aspects of the superior, middle, inferior, and frontal gyri	• Primary cognition, including attention and working memory • Executive functions like multitasking, organizing, and decision making	• Impaired executive functions • Impaired short-term and working memory
Prefrontal Cortex	n/a	• Judgment and insight • Safety awareness	• Impaired judgment

Ventromedial Prefrontal Cortex	Orbitofrontal and orbital gyri	• Work in conjunction with the limbic system to integrate personality and control emotions • Cognition, preference, and judgment	• Damage to the right side results in impaired impulse control • Damage to the left side results in depressive symptoms

The parietal lobe is located behind the frontal lobe on top of the head. This lobe of the brain is primarily responsible for:

- Recognizing and interpreting taste
- Understanding spoken and written language
- Spatial orientation
- Movement coordination
- Understanding speech intonation, symbols, and visual perception
- Being aware of, interpreting, and integrating various types of sensory information
    - Taste
    - Smell
    - Sight
    - Touch
    - Spoken and written language
    - Temperature
    - Limb position
    - Pain

The temporal lobe is located behind both ears. This is considered the second-largest lobe of the brain aside from the frontal lobe. The temporal lobe controls the following:

- Awareness and recognition of smell
- Emotion control
- Awareness, recognition, and perception of auditory stimuli
- Memory acquisition
- Object and face recognition

The occipital lobe is located in the rear of the head just at the base of the skull. This part of the brain is responsible for:

- Awareness and interpretation of visual input (called visual processing)
- Visual memory
- Processing macular vision
- Distance and depth perception
- Object and face recognition
- Memory formation
- Color determination

Area	Location within the Lobe	Function	Presentation after Injury

Primary Somesthetic Area	Postcentral gyrus	• Awareness of primary tactile sensations (touch, pain, temperature, and limb location), vibratory sense, and conscious proprioceptive inputs	• Paresthesias
			  ○ Tingling
			  ○ Pricking
			  ○ Burning sensation of the skin
			  ○ Phantom limb
			  ○ Anesthesia

Secondary Somesthetic or Sensory Association Area	Superior parietal lobule	• Interpretation of primary sensations
		• Cortical sensation
		  ○ Two-point discrimination
		  ○ Graphesthesia
		  ○ Stereognosis
		  ○ Bilateral integration
			• Astereognosis
			• Anosognosia
			• Positive extinction sign

Angular Gyrus and Supramarginal Gyrus	Angular gyrus and supramarginal gyrus	• Dominant side of Wernicke's Area: understanding spoken and written language • Non-dominant side: understanding speech intonation, symbols, and visual-perception (including top, bottom, right, left, and spatial orientation)	• Dominant side: receptive or global aphasia • Nondominant side: neglect, inattention, visual-perceptual disorders, and visual-spatial disorders

Gustatory Area	Inferior portion of postcentral gyrus	• Recognition and interpretation of taste	• Impaired taste perception
Primary Auditory Area	Transverse temporal gyri	• Awareness of auditory input	• Auditory agnosia
Secondary Auditory Area	Superior temporal gyrus	• Interpretation of auditory inputs	• Dominant side: Wernicke's aphasia • Auditory agnosia, especially acoustic verbal agnosia
Temporal Pole	Anterior portion of temporal lobe on lateral side	• Works with the ventromedial PFC to help people cortically control emotions through the uncinate fasciculus	• Inability to control emotions
Primary Olfactory Area/ Uncus	Uncus	• Awareness and recognition of olfactory input	• Olfactory agnosia, parosmia
Primary Visual Area	Calcarine area	• Awareness of visual input • Processing of macular vision	• Cortical blindness
Visual Association Area	Occipital cortex	• Understanding and interpreting visual input • Creating visual memories	• Visual agnosia • Prosopagnosia • Visual inattention

If the left MCA is primarily affected, an individual will experience aphasia, whereas if the right MCA is primarily affected, someone can expect to experience unilateral neglect and

spatial dysfunction. While it sounds more generalized, unilateral neglect is the result of a stroke on the right side of the brain. If someone experiences unilateral neglect, they will have decreased awareness of sensory input coming from the left side of their body. Impairments involving the internal carotid artery (ICA) yield the same impairments.

If someone has a stroke that involves a blockage or hemorrhage in the anterior cerebral artery (ACA), they are likely to experience contralateral hemiplegia, impaired grasp reflex, incontinence, confusion, apathy, and mutism. Hemiplegia refers to muscle weakness or paralysis on one side of the body. But therapists should be aware that an ACA stroke can also cause impaired spinal reflexes. Therapists need to recognize this because they might initially group an impaired grasp reflex in with the other symptoms of hemiplegia.

If a stroke impacts the posterior cerebral artery (PCA), someone will usually experience homonymous hemianopsia, hemi-sensory loss, and alexia. The PCA innervates the thalamus, which is a small part of the brain located just above the brainstem. The role of the thalamus is to communicate both motor and sensory information to the cerebral cortex. Someone who suffers a stroke in this region of the brain (a thalamic stroke) might be left with severe chronic pain referred to as Dejerine–Roussy syndrome or thalamic pain syndrome. This particular condition is present in around 8% of individuals who experience a thalamic stroke. Unfortunately, thalamic pain is one of the most complex stroke-related concerns to manage since it is treatment-resistant, healthcare providers cannot predict who it might affect, and it can be difficult to diagnose in patients with aphasia or other communication deficits.

Individuals who experience a blockage in or hemorrhage of the ACA, PCA, or superior cerebellar artery are also at risk of experiencing a cerebellar stroke. There is only a 10% chance that someone will experience a cerebellar stroke. When this does it occur, it's due to oxygen loss and impaired blood supply to the cerebellum, which is a small area located at the back of the brain just under the occipital lobe. Those who experience a cerebellar stroke are likely to experience acute vestibular syndrome. This causes them to experience pseudobulbar signs, which include dysarthria, dysphagia, emotional instability, and tetraplegia. Symptoms of a cerebellar stroke include dizziness, headache, ataxia, tremors, jerking motions, vertigo, slurred speech, and uncontrollable eye movements.

One of the most obvious ways to differentiate between pseudobulbar signs and other stroke outcomes is through the presence of pathological laughter and crying associated

with the pseudobulbar affect (PBA). This causes people to frequently erupt into uncontrollable, involuntary episodes of crying and laughter. Episodes will begin with one emotion and lead to the other. There are no known triggers for these behaviors and, therefore, it is not possible to predict the episodes. This type of emotional instability is distinctly different from what is usually experienced after a stroke. PBA can also impact people with other neurological conditions, such as multiple sclerosis, Alzheimer's disease, amyotrophic lateral sclerosis (ALS), and Parkinson's disease.

As you can see, damage to just one of the brain's structures can have widespread effects that impact someone's functional abilities. While the brain's functions do differ based on location, it is a common misconception that someone can be more right-brained than left-brained and vice versa. Based on the concept of hemisphere specialization, it's more accurate to say that each part of the brain is capable of processing nearly any type of input but does so in different ways. This concept is also known as cerebral dominance because each part of the brain (specifically the two hemispheres) performs best when interpreting certain information.

As it pertains to stroke diagnosis, hemisphere specialization means that an infarct or other lesion will have a very specific functional impact on a person. However, this works to a person's benefit in terms of stroke rehabilitation. This is because the concept of neuroplasticity proves that someone's brain can, to an extent, recover from injuries. The depth of a person's neuroplasticity depends on a variety of factors, including the presence of skilled rehab, the immediacy of nursing care after a stroke, and the presence of comorbidities. Yet, when given the right tools, a person can be retrained after an incident such as a stroke. Neuroplasticity works in our favor to help our brain develop new neurons, build new connections, and learn new skills.

Based on the general strengths of each hemisphere, a person with a stroke affecting the left hemisphere might experience some of the following deficits:

- Limited or absent movement, sensation, and/or vision on the right side of the body and/or in the right visual field
- Apraxia, specifically related to oral-motor skills
- Impaired visual-verbal processing
- Deficient spatial processing

- A lack of insight (which often leads to impulsive behaviors)
- Aphasia along with limited or absent bilateral auditory reception
- Poor verbal memory

A clinician can expect some of the following symptoms and behaviors in a person who has experienced a stroke affecting the right hemisphere:

- Impaired or absent movement, sensation, and/or vision on the left side of the body and/or in the left visual field
- Poor nonverbal memory
- Emotional instability, including symptoms of depression and anxiety (this largely stems from insight remaining intact)
- Inability to interpret abstract information
- The presence of tonal inflections that impact speech production (this is present due to dysarthria and dysphagia)
- Inattention
- Poor nonverbal auditory processing
- Neglect

Section 2 Personal Reflection

What other conditions might the concept of neuroplasticity apply to?

Section 2 Key Words

Anosognosia: When someone lacks insight into their own condition, limitations, or deficits

Alexia: The inability to read and grasp written language

Apraxia: The inability to learn, sequence, and execute new motor commands

Astereognosis: When someone lacks the inability to identify physical objects using only their tactile system and not their visual system

Auditory agnosia: The inability to recognize sounds in any form (written, auditory, or spoken)

Contralateral: Referring to the opposite side of the body; in reference to stroke, contralateral is used to describe symptoms that occur on the opposite side of the body from the hemisphere that has been injured

Dyspraxia: Difficulty coordinating movements in a smooth, even manner

Expressive aphasia: The inability to verbally communicate in a way that other people understand; also known as Broca's aphasia since it affects a part of the brain called Broca's area

Global aphasia: A syndrome that prevents someone from effectively verbally expressing themselves and understanding what others say to them; this combines both Wernicke's aphasia and Broca's aphasia

Graphesthesia: When someone is unable to recognize symbols that are drawn or traced on the skin without watching

Hemianesthesia: A loss of sensation on one side of the body

Macular vision: A type of vision that works in combination with light coming through the retina

Neuroplasticity: The brain's ability to grow, change, and adapt over time; this occurs throughout the course of a typical person's lifetime, but also in response to certain experiences, events, and injuries, such as a stroke

Olfactory agnosia: The inability to identify objects based on smell

Paresthesia: Abnormal sensation, which often involves symptoms such as pins and needles (numbness and tingling), burning, skin crawling, and itching; this most often impacts the arms and legs but can occur elsewhere

Perseveration: The inability to terminate a motor plan or command

Prosopagnosia: The inability to recognize faces; also known as face blindness

Pursuits: Eye movements that involve keeping your line of sight on one moving object; also known as tracking

Receptive aphasia: The inability to understand what others are verbally saying; also known as Wernicke's aphasia

Saccades: Eye movements that involve searching the whole environment for relevant stimulus; also known as scanning

Thalamic pain syndrome: A treatment-resistant, chronic pain condition that may result after someone experiences a thalamic stroke

Two-point discrimination: The ability to recognize and identify the distinct difference between two separate objects touching the skin and not just one

Unilateral neglect: A symptom resulting from a stroke in the right hemisphere that causes someone to be inattentive to sensory stimulus on the left side of their body

Upper motor neuron sign: Bodily indications that upper motor neurons in the brain have been injured; these signs include spasticity, muscle weakness, increased fatigability, and poor muscle control, clonus, and a Babinski response

Section 3: Risk Factors and Warning Signs [1,2,3,4,13,14,15,16,17,18]

There are many risk factors for a stroke. Some of these factors can be changed while others cannot be. In particular, many medical conditions place someone at a greater risk of stroke. You will notice that many of the health concerns on this list involve the circulatory system, which is no coincidence since the health of the blood vessels in the body impacts the health of the vasculature in the brain. The good news is that these health concerns are largely manageable. The following are modifiable risk factors that can be altered to lower someone's risk of stroke:

- Hypertension
    - This pertains to any levels that are higher than the standard 120/80 mm/Hg, but people whose blood pressure exceeds 140/90 mm/Hg are particularly at risk
- Diabetes mellitus
    - High blood glucose levels can damage blood vessels

- Any form of heart disease, including an abnormal heart rate (arrhythmia), atrial fibrillation, congestive heart failure (CHF), carotid artery disease, peripheral artery disease, and faulty valves within the heart
- Sickle cell anemia
    - This rare condition causes blood cells to adhere to vessel walls, which blocks blood flow.
- Taking oral contraceptives or hormone replacement therapy (HRT)
    - The hormones found in these medications, particularly estrogen, increase the body's clotting abilities.
- A sedentary lifestyle
    - Healthy blood vessels are those that can keep blood pumping by eliminating fat from their walls; exercise helps improve this blood flow.
- Smoking
    - The chemicals found in traditional cigarettes not only decrease the presence of oxygen in the blood, but they also raise blood pressure levels and increase heart rate. This pertains to people who smoke and those who inhale secondhand smoke.
- An unhealthy diet
    - There are many worldviews on what exactly constitutes an unhealthy diet. But diets that increase stroke risk are high in saturated fat and salt, and low in vegetables, fruits, and fiber.
- Migraines with aura
    - This changes the structure of blood vessels in the brain, heart, and neck, which can impact stroke risk.
- Obesity
    - Being any amount overweight causes health concerns such as high blood pressure and hypercholesterolemia. These both cause problems with blood vessels, which increase stroke risk.

- Illegal drug use, particularly intravenous (IV) drugs and cocaine
    - Any drug that is continually injected places undue stress on blood vessels by causing them to rapidly expand in a spasm-like motion. Drugs like cocaine and methamphetamines cause a prolonged increase in heart rate, which strains the heart.
- Regular or excessive alcohol use
    - This raises someone's blood pressure and, in turn, their risk of stroke. Depending on your gender, this means no more than one or two drinks per day.
- Geographic location
    - It's unknown why, but evidence shows that strokes more commonly affect people living in the southeastern United States. This may be due to diet, lifestyle, and race, which makes this a partially modifiable risk factor.
- Climate
    - Statistics show that strokes occur more often during the summer months or times of extreme temperatures.
- High levels of blood cholesterol and lipids
    - This hardens the arteries and makes it more difficult for blood to pass through the vasculature.
- Viral infections, including but not limited to COVID-19
    - This respiratory condition (and similar ones) places someone at a greater risk of clotting.
- Inflammatory conditions, such as rheumatoid arthritis, lupus, tuberculosis, and Crohn's disease
    - Chronic inflammation located anywhere in the body can lead to the growth of arterial plaque. These conditions can also cause these plaques to break loose and enter the bloodstream in the form of a clot, which can then travel to the brain.

- Sleep disorders, including sleep apnea and restless legs syndrome (RLS)
    - Sleep apnea prevents proper breathing, which limits the flow of oxygen to the brain and other parts of the body.
- Working or living in buildings or cities with high amounts of air pollution
- A history of transient ischemic attacks, brain aneurysms, or the presence of an AVM
    - As we've mentioned, once someone experiences a TIA, they are at a higher risk of sustaining a full-blown ischemic stroke.
- Taking blood-thinning medications
    - While this drug lowers someone's risk of forming a clot, it increases their risk of bleeding and, thus, hemorrhagic strokes.
- A high red blood count
    - Increases someone's risk of clotting

On the other hand, there are also nonmodifiable risk factors for stroke that are difficult to avoid. While therapists and other healthcare providers cannot change these circumstances, they can educate individuals about each of them to increase awareness of their chances of having a stroke:

- Age
    - Stroke can impact anyone, but there is a greater risk when someone is over 55 years old.
- Gender
    - Women are more likely to experience fatal strokes, while strokes are more likely to occur in men.
- Genetics
    - Individuals are at greater risk if they have a family history of stroke.
- Race

        - Black and Latinx individuals are more likely to suffer from high blood pressure, which places their risk of stroke at nearly double the rate of white individuals.
- Having type AB blood
    - People with type AB blood have the highest clotting levels of all blood types, while people with type O blood are more likely to bleed.
- Socioeconomic status
    - Some studies present a potential correlation between earning a lower income and experiencing a greater risk of stroke.

Therapists can use these risk factors to weigh a person's chances of experiencing a stroke and, therefore, inform preventive measures. Another way that therapists can provide education surrounding stroke is by informing at-risk individuals (and their caregivers, family members, etc.) of the warning signs of a stroke. If these individuals know what signs and symptoms to look for, they can take action more quickly. By taking the right steps after identifying warning signs, patients can then get the treatment they need to minimize long-term damage. As we've mentioned before, time is of the essence, so these warning signs are another crucial aspect of stroke rehabilitation. Patients and caregivers should be educated to look for the sudden onset of any of the following symptoms:

- Weakness or numbness in just one side of the body (face, arm, or leg, particularly)
- Dizziness or loss of coordination
- Trouble walking, standing, or keeping balance
- Severe headache with unknown origin
- Confusion or drastically impaired speech
- Blurred vision in one or both eyes

Be sure to emphasize that each of these symptoms should be sudden (meaning they come on with no warning) and severe with significant impairment in a short period.

Patients and caregivers should look for those two indicators, but it is still recommended to call 911 if they are concerned.

An easy way to remember the above warning signs is using the acronym FAST, where F stands for the face, A stands for the arms, S stands for speech, and T stands for time. If patients or caregivers suspect a stroke, they should go through these letters to "screen" themselves.

F - Trying to smile will indicate whether or not one side of the face is drooping.

A - By trying to raise both arms, it will be obvious whether or not one arm has impaired motion.

S - Verbalize a simple phrase for your loved one to repeat to see whether speech is slurred, slow, or different from how they usually speak.

T - Again, time is a major factor in stroke rehabilitation, so call emergency services as soon as you notice the above signs or suspect a stroke.

As mentioned before, a TIA is another warning sign of a stroke. A TIA may occur days or even weeks before an ischemic stroke, so intervention and treatment should be able to help with this. Symptoms of a TIA might include a brief bout of numbness and tingling or an unexplained headache. These will resolve on their own a short time after they begin. However, if someone is knowledgeable about the signs and symptoms of a stroke, they will know to seek medical attention. This will help them confirm that the incident, in fact, was a TIA and learn how they can prevent an ischemic stroke from occurring in the future.

Section 3 Personal Reflection

How might an occupational therapist help someone who has just experienced a confirmed TIA?

Section 3 Key Words

Migraine with aura: A severe, persistent headache that is accompanied by visual symptoms, such as flashing lights and squiggly lines; aura symptoms usually come before the headache starts, but they can also be connected to seizures or other similar neurological conditions

Restless legs syndrome (RLS): A sleep-related condition that causes someone to experience an intense urge to move their legs; RLS can also cause burning, tingling, and numbness in the legs; while RLS itself is not a risk factor for stroke, it can lead to sleep deprivation, which places someone at a greater risk of stroke

Sickle cell anemia: A rare condition that causes red blood cells to become misshapen, which leads to symptoms such as fatigue, pain, as well as an increased risk of clotting due to obstructed pathways

Sleep apnea: A condition that causes someone to spontaneously stop breathing as they sleep; this can cause someone to experience impaired sleep, which increases stroke risk; sleep apnea can only be treated using a continuous positive airway pressure (CPAP) machine

Section 4: Medical Evaluation for a Stroke [19,20,21,22,23]

In order to get someone the right type of treatment after a stroke, it is crucial to begin with a formal and accurate diagnosis. For doctors to diagnose a stroke, their medical evaluation must consist of some basic information, such as their medical history, current medications, and a list of the risk factors that pertain to them. But it's just as important for doctors to complete other testing that assesses a patient's motion, strength, speech, and cognition. They must also use imaging techniques to get a clear picture of the brain.

Doctors commonly use computed tomography (CT) scans and magnetic resonance imaging (MRI) to determine the state of the brain. CT scans use electromagnetic energy to create a three-dimensional image of bones, tissues, and organs by taking multiple x-rays from various angles. An MRI uses magnetic fields to create precise imaging of the brain, spinal cord, tendons, ligaments, muscles, cartilage, and bones.

Both of these imaging techniques can be used on the entire body to help doctors check for global abnormalities or they can be used on specific parts of the body, such as the head, abdomen, or chest, to get a more complete picture of smaller structures. In the instance of a potential stroke, both of these tests focus solely on the head so they can reveal the presence of tissue death or internal bleeding.

For many years, CT scans were the industry standard if a provider suspected a stroke since they are faster than traditional MRIs at differentiating between a hemorrhagic stroke and an ischemic stroke. This was the case until 2010 when the American Academy

of Neurology changed their guidelines to state that a type of MRI called diffusion-weighted imaging is the best tool to diagnose ischemic strokes within 12 hours of the first symptom. These developments came following several large research studies that showed diffusion MRIs were 83% effective at correctly diagnosing ischemic strokes compared to just 26% effectiveness with CT scans. This same study also showed that diffusion MRIs more accurately assisted in detecting lesions and stroke severity. Diffusion MRIs were also found to aid doctors in diagnosing other neurological conditions based on their findings. A diffusion MRI involves measuring the speed of water molecules within the brain. This gives doctors an immediate picture of where this movement stops altogether, therefore indicating what areas of the brain are occluded. Diffusion MRIs are far faster than traditional MRIs and even faster than CT scans.

A functional MRI (fMRI) is another subset of this imaging test that can be used to monitor a patient's brain recovery following stroke diagnosis and treatment. This takes a bit longer to complete, which is why it plays a role in determining progress as part of long-term treatment and not the diagnostic process. fMRIs are used to monitor minute changes in blood flow, which can indicate the return of skills such as motion and speech. One study that used fMRI showed that rehabilitation had a notable effect on cortical connections that govern sensorimotor function.

In recent years, these imaging tests have grown increasingly precise. This is equally beneficial for diagnosis and treatment since doctors will often use the results from these tests to determine whether or not certain procedures can be performed.

While blood tests are not used to diagnose a stroke, they do help doctors determine the cause of the stroke if it is unknown. Therefore, doctors will usually do a series of blood tests to get to the root of the problem and prevent another stroke from occurring. These tests include:

- Complete blood count (CBC)
- Platelet count
- Blood glucose levels
- Blood lipid tests
- Electrolytes
- Thyroid tests

- Blood protein tests
- Coagulation tests
- Blood chemistry tests

An electrocardiogram (ECG or EKG) is another tool used to diagnose stroke. Since ECGs measure the rhythm, strength, and timing of the heart, they can be used to determine whether or not cardiac concerns caused the stroke. One dated study noted that an ECG of someone who had a stroke might show one of the following: T wave inversion, arrhythmia, ST depression, prolonged Q wave, or the presence of a U wave. T wave inversions were the most common indication of ischemic and hemorrhagic strokes, while arrhythmia was only noted in hemorrhagic strokes. Patients who experienced ischemic strokes along with changes in the ST segment of their heart rate experienced a higher mortality rate. Those who suffered a hemorrhagic stroke and displayed a U wave in their heart rate were more likely to experience fatal effects from their stroke.

Doctors might also perform an ultrasound on the carotid artery, which is located in the neck. Blockages and plaque build-up in this artery can be a cause of stroke for some people, so identifying this concern can help with diagnosis and treatment. Another test is cerebral angiography, which involves using an x-ray to isolate and take imaging of the blood vessels in the brain. The results of this test are called an angiogram.

Section 4 Personal Reflection

How might a therapist interpret the results of an fMRI to inform their treatment goals?

Section 4 Key Words

Complete blood count: A type of blood test that measures red blood cells, white blood cells, hemoglobin levels, platelet count, and hematocrit to determine a person's health; also known as a CBC

Diffusion-based imaging: This type of MRI measures the speed of water molecules in the brain and is used to determine the presence and location of any cerebral blockages

Functional MRI: This type of MRI takes detailed measurements of blood flow in the brain to help detect blockages; also known as an fMRI

Section 5: Medical Interventions for a Stroke

24,25,26,27,28,29,30,31,32

The form of emergency treatment a person receives is dependent on the type of stroke the person sustained. For each type of stroke, there are both pharmacological and surgical interventions. Based on the person's condition and comorbidities, doctors may recommend any combination of these treatments.

Pharmacological Treatments

If a person experiences symptoms associated with an ischemic stroke, they usually benefit most from intravenous medication that helps dissolve the clot, speeds up the return of blood flow to the brain, and decreases the severity of the stroke. A medication called tissue plasminogen activator (TPA) is most effective when given within 3 hours of the first stroke symptom, but some studies show it can also be effective within a 4.5-hour window. TPA does come with a risk of brain bleeding in the event it is inappropriately given to someone with a hemorrhagic stroke. For this reason, doctors need to make an accurate diagnosis of ischemic stroke before administering TPA.

After a person is rehabilitated from a stroke, they will likely be prescribed medications to help prevent another stroke from occurring. Antiplatelet drugs and anticoagulants manage or prevent clots in individuals after an ischemic stroke. Antiplatelet drugs are used to inhibit a person's natural clotting abilities by preventing platelets from sticking together. A daily regimen of aspirin is usually recommended since this is one of the most common and readily available antiplatelet drugs. People who are already at a high risk of bleeding or those who have allergies may not be appropriate for this type of medication, so anticoagulants are another option.

Anticoagulants, also known as blood thinners, interact with a different blood component to prevent clots. But they are dual-functioning in that they also prevent existing clots from growing. The two most prominent anticoagulants are Heparin, which is a short-term option commonly used during hospitalizations, and Warfarin - a long-term term choice that needs several days to take effect. Individuals taking Warfarin should avoid grapefruit and cruciferous vegetables, since these decrease its absorption and effectiveness, respectively. While anticoagulants and antiplatelet drugs have similar effects, anticoagulants are usually prescribed for individuals with deep vein thrombosis (DVT) as a result of immobility secondary to a stroke or atrial fibrillation.

Depending on the extent of co-occurring conditions that result from a person's stroke, they may also benefit from antidepressants, medications that address tone concerns such as spasticity (Botox is a common one), and pain medications. Patients who experience a stroke may also develop osteoporosis, so their doctor may recommend calcium and Vitamin D supplementation.

Aside from medications that treat stroke, doctors may also prescribe medications that manage health concerns that can cause a stroke. These commonly include hypertension, atrial fibrillation, and high cholesterol. Individuals with atrial fibrillation may need heart rhythm medications, which include sodium channel blockers and potassium channel blockers.

Individuals whose high blood pressure or high cholesterol levels contributed to their stroke will be placed on medications to manage those health concerns and decrease a person's risk for future stroke. Many anti-hypertensive medications also serve the purpose of regulating the speed of a person's heart rate, which also helps in reducing stroke risk. Blood pressure medications might include those in the following categories:

- Angiotensin-Converting Enzyme (ACE) Inhibitors
- Diuretics
- Beta blockers
- Calcium channel blockers
- Angiotensin Receptor Antagonists (ARBs)

Doctors may also prescribe one or more of the following medications to regulate blood cholesterol levels:

- Statins
- Fibric Acid Derivatives
- Niacin
- Resins
- Cholesterol Absorption Inhibitors

In some cases, individuals with normal cholesterol levels might be prescribed statins since they are regarded as quite effective at generally lowering stroke risk.

Surgical Treatments

There are some instances of ischemic and hemorrhagic stroke where patients do not respond to medications or are not able to take pharmacological treatments because of medical concerns. If this is the case, surgery is often necessary to remove clots and manage internal bleeding.

Patients who experience an ischemic stroke may undergo a carotid endarterectomy, which is a procedure that removes clots and plaque surrounding the carotid arteries in the neck. This is intended to widen arteries and improve blood flow from the neck and heart to the brain. A carotid endarterectomy is indicated if clogged carotid arteries are the cause of a stroke. This procedure is considered high risk for patients with heart conditions.

Other endovascular procedures may be warranted for individuals who experience an ischemic stroke. One of the most common of these procedures involves injecting TPA (the clot-dissolving agent) directly into the part of the brain affected by the stroke. This rapid delivery means that doctors can administer it within 4.5 hours of the first symptom, compared to the stricter 3-hour window for injected TPA. Another vascular procedure involves the use of a stent and catheter to remove the clot. This procedure is commonly performed after TPA is administered since it's most suitable for clots that are too large for the medication to completely dissolve.

A thrombectomy is a procedure used to treat ischemic strokes since it involves removing the clot from the blood vessel. There are two ways that doctors do this: one is by using suction from a catheter and another is by mechanically breaking up the clot before removing small pieces one by one.

There are also surgical procedures to treat hemorrhagic strokes. The most well-known of these surgeries is a craniectomy, which also comes along with a much higher risk than the other procedures. A craniectomy involves removing a portion of the skull bone to relieve internal pressure on the brain. In most cases, this piece of bone is frozen and replaced months later once the swelling has gone down. The procedure to replace this bone is called a cranioplasty. A craniectomy may also be completed so surgeons can

remove an AVM that is at risk of rupturing. Surgeons do this by sealing both ends of the AVM and removing it as a unit.

Another similar, but slightly less invasive procedure is a craniotomy. During a craniotomy, small holes are made in the skull. A burr hole is placed at the top of the skull and a keyhole goes above the eye socket. These tunnels are typically used to insert devices or tubes. In the case of hydrocephalus, where there is increased pressure on the brain due to an accumulation of fluid, surgeons will place a shunt that directs the fluid elsewhere. Doctors might also use these holes to insert an intracranial pressure monitor into the brain, which records internal pressure levels over time. A surgical clipping is often paired with a craniotomy, which involves placing a small clip on the blood vessel that is hemorrhaging to stop the bleeding. This is another instance where accurate diagnostic imaging is so crucial since doctors must know where the hemorrhage is coming from to quickly locate and control the source of the aneurysm.

Individuals are usually sedated for the bone removal or hole insertion and are then awakened while work is being done on the brain itself. This is especially crucial when surgeons are working near areas of the brain that govern speech and language. Recovery from each of these surgeries usually takes several months.

Certain hemorrhagic strokes (and AVMs) can also be treated through endovascular coiling. This involves inserting a catheter, which travels from the femoral artery in the leg up to the brain, to place an ultra-thin platinum coil in the area that sends the aneurysm blood. Endovascular embolization is a sister procedure that uses the same process to insert glue or other materials in the aneurysm to prevent any blood from flowing through it. These two procedures can be used to repair aneurysms that have already ruptured or to prevent the hemorrhage of an existing aneurysm. These endovascular procedures involve the use of contrast dye to guide surgeons in the correct placement, so they are not suitable for anyone with a dye allergy. Anyone who is prescribed blood thinners needs to stop taking these medications several days before the procedure. Endovascular coiling and embolization both come with the risk of stroke, clots, hematomas, aneurysm rupture (if it was not previously ruptured), and recurrent aneurysm.

The remaining procedure is stereotactic radiosurgery. This is entirely non-invasive since it uses very sensitive therapeutic radiation to remove AVMs. Stereotactic radiosurgery is also effective in treating other central nervous system abnormalities such as trigeminal neuralgia, epilepsy, and cancer. After several sessions, the x-rays will have destroyed

enough AVM cells that the remaining ones will slowly shrink and cannot grow back. Since stereotactic radiosurgery is non-invasive, it does not place someone at risk of infection, stroke, or serious complications like a craniotomy or craniectomy would. However, individuals who undergo this procedure may experience side effects such as seizures, paresthesias, headaches, hair loss, and gastrointestinal symptoms.

Many procedures have evolved over the years to improve the functionality of a person who has experienced a stroke. Some are more appropriate for certain types of stroke, while others (such as craniotomies) are used as a means to implement a more specific treatment. Each procedure has risks, so therapists must be aware of a patient's medical and treatment history to determine what complications might arise and how they may impact rehabilitation.

Section 5 Personal Reflection

What might an occupational therapist's treatment focus on just after one of these procedures?

Section 5 Key Words

Anticoagulants: Medications that slow down the clotting process; also known as blood thinners

Antiplatelet drugs: Medications that prevent blood cells from sticking together in an attempt to stop the clotting process

Atrial fibrillation: A rapidly irregular heart rate that places someone at risk for stroke

Carotid endarterectomy: A surgical procedure that involves removing fatty build-up (plaque) and clots from the carotid arteries in the neck; this can treat an ischemic stroke

Craniectomy: A surgical procedure that involves removing a portion of the skull to relieve pressure on the brain after a hemorrhage; the bone is usually replaced several months later in a procedure called a cranioplasty; this can treat a hemorrhagic stroke or an AVM

Craniotomy: A surgical procedure that involves placing two small foramen (a burr hole and keyhole) in the skull in order to place a shunt, clip a hemorrhaging blood vessel, or

place an intracranial pressure monitoring device; this can be treat a hemorrhagic stroke or an AVM

Deep vein thrombosis: A condition that involves the formation of a clot in a major vein; this usually occurs in the leg or arm and is considered an emergency, since any abrupt movements can send the clot to the heart, brain, or lungs; also known as DVT

Endovascular coiling: A surgical procedure that uses a catheter to insert a platinum coil in a blood vessel; this is placed in the area that supplies an aneurysm with blood to stop a hemorrhage; this can treat a hemorrhagic stroke or an AVM

Endovascular embolization: A surgical procedure that uses a catheter to insert metal, glue, or another material into a blood vessel; this is placed in the aneurysm itself to stop bleeding; this can treat a hemorrhagic stroke or an AVM

Endovascular procedure: A minimally-invasive procedure used to treat internal vasculature such as blood vessels, arteries, and veins

Hydrocephalus: An excess of fluid found within the brain; this causes increased pressure, swelling, and can make the head look visibly swollen from the outside

Stereotactic radiosurgery: A non-invasive procedure that uses precise therapeutic radiation to remove AVMs and other central nervous system abnormalities

Thrombectomy: A surgical procedure that involves physically removing a clot from a blood vessel; this is done using suction from a catheter or by mechanically breaking it up; this can treat an ischemic stroke

Tissue plasminogen activator: A medication used to dissolve a clot; it is only effective when given between 3 and 4.5 hours of the first ischemic stroke symptom; this can be administered intravenously (in the arm) or directly into the brain for more rapid delivery; also known as TPA

Section 6: Therapeutic Interventions [33,34,63]

There are many professionals involved in the care of a person who has experienced a stroke. This is especially true in the acute stages since the majority of research shows that heightened neuroplasticity typically lasts between 3 and 6 months after a stroke. However, more recent studies have shown that this window might extend as long as 12

months after the neurological event. Either way, this is considered the time when the most therapeutic gains can be made. But therapies often continue beyond this point and into the chronic stages of stroke.

Rehabilitation is a major part of this recovery period and, depending on a patient's level of impairment, all disciplines are typically involved. When physical therapists are treating individuals who have experienced a stroke, their early treatment sessions will have a strong focus on neuromuscular reeducation and balance training. Based on the patient's needs, a physical therapist will often start acute treatment by addressing:

- Bed mobility and basic transfers
- Pain, if the patient is in discomfort
- Prevention efforts for stroke complications
    - For example, a common complication of stroke is joint subluxation, specifically of the glenohumeral joint in the shoulder. If a patient is at risk for this due to substantial nerve loss in their arm, PTs will recommend a sling to keep the shoulder in a protective position.

If there are no initial safety concerns in these areas or a patient has met goals in these areas, PTs may address other concerns, including:

- Fitting and fabrication of orthotics and prosthetic devices
- Balance, coordination, and strength as it pertains to walking and transferring
- Measurement and customization of wheelchairs, rollators, standard walkers, canes, or other mobility devices
- Acupuncture
    - One study showed that needle-pricking can increase lower body motion, particularly in the foot, in chronic stroke patients.
- Aquatic therapy
    - This allows patients to work on improving basic motions (with supervision and direct support from a trained therapist) in a gravity-eliminated setting. Aquatic therapy can also help with pain relief and relearning proper body mechanics.

- Bodyweight support
    - This involves walking on a treadmill with the assistance of a device that carries some of the patient's weight. The amount of assistance the device provides can be decreased over time to slowly improve a patient's posture, balance, and strength.

Speech-language pathologists, also known as speech therapists, are also an important part of stroke rehabilitation. Again, the role that speech therapists play in the rehab process will depend on the severity of the stroke and the area of the brain that the stroke affected. Speech therapists can address some of the following areas:

- Identifying, matching, and recognizing objects
- Strengthening oral-motor skills to improve the ability to breathe, eat, and speak
    - This includes motion and strength of the tongue, lips, jaw, and cheek.
- Word generation to improve expressive language
- Articulation skills to improve others' ability to comprehend their speech
- Reading comprehension skills to improve receptive language
- Visual attention
- Sequencing tasks
- Short-term memory and information recall

Stroke rehab must also include treatment (or at the very least, screening) from psychiatrists and psychologists. This is because many types of stroke, particularly those that impact the frontal lobe, affect a person's mood, emotion regulation, and behavioral control. In some cases, these patients will develop mental health concerns such as anxiety or depression. They can also experience impulsivity and limited insight, which impacts their safety and quality of life. Some patients may benefit from seeing a psychologist to manage these concerns, help adjust to their condition, and come to terms with potentially lasting physical effects of their stroke. Psychologists offer individual and group psychotherapy focused on a range of topics, including:

- Anger management

- Interpersonal relationships
- Communication skills
- Adjustment to change
- Self-control and self-management
- Family dynamics
- Healthy sleep
- Motivation
- Cognitive impairments
- Coping skills
- Building confidence and self-esteem
- Finding support groups

Treatments might include cognitive behavior therapy (CBT), positive psychology, psychotherapy, motivational interviewing, and mindfulness.

Psychological care alone might be enough mental health treatment for individuals with minor concerns. However, most people who experience mental health concerns secondary to a stroke will also need medication management and counseling provided by a psychiatrist. Psychiatrists will often prescribe antidepressants to help individuals manage symptoms of chronic depression that may occur after a stroke. Selective serotonin reuptake inhibitors (SSRIs) are one of the most common antidepressants used for this purpose. SSRIs not only carry the lowest risk due to minimal side effects and interactions but they are also considered the most effective for elderly individuals with stroke. Similarly, benzodiazepines are viewed as the best way to directly treat anxiety that may result after a stroke. In addition to medications, psychiatrists can also provide individual and group counseling to help manage a range of mental health concerns.

Section 6 Personal Reflection

How might an occupational therapist collaborate with a psychologist to provide effective mental health care for a patient who has experienced a stroke?

Section 6 Key Words

Aquatic therapy: Exercise-based treatments performed in the water for the sake of strengthening, relaxation, and improved motion; therapeutically, these sessions are completed with the constant assistance of a PT or OT who is trained in aquatic therapy

Bodyweight support: A treatment modality that involves walking on a treadmill with the assistance of a device that carries part of your weight; gains are made by gradually decreasing the amount of assistance the device provides

Joint subluxation: Partial dislocation of a joint; this may result from an injury, a medical condition, or dysfunction of the muscles and ligaments intended to hold joints together

Orthotics: Custom-made, wearable medical devices intended to help treat a certain type of dysfunction in the body

Positive psychology: A subset of psychology that involves a strong focus on the strengths and assets of both individuals and society; this is used to enable success in individuals and the communities they are part of

Prosthetics: Custom-made, wearable medical devices intended to serve as artificial joints for people who have lost limbs such as an arm or leg

Psychotherapy: The treatment of mental health concerns using talk therapy and counseling

Rehabilitation: A field that includes physical therapists, occupational therapists, and speech-language pathologists who help patients recover, get stronger, and build skills after an injury, surgery, or illness

Section 7: Stroke Evaluations [35,36,37,38,39,40,41,42,43,44,45,46]

An occupational therapy evaluation for an individual who has experienced a stroke should begin with an occupational profile. The therapist should gather information about the patient's values, interests, relevant contexts, barriers to participation, daily life roles, patterns of engagement, and priorities. It may be difficult for therapists to get some of these answers directly from the patient, since communication deficits may prevent this from happening. However, therapists should be sure to obtain this

information from family members, friends, caregivers, and the patient's medical record, if they have had a thorough history taken at another time.

Standardized assessments should be the biggest part of the evaluation since the scores from these tests will help therapists develop goals and form an appropriate treatment plan. Some of the following standardized assessments are ideal for patients who have experienced a stroke:

National Institutes of Health Stroke Scale (NIHSS)

This assessment was designed for physician use and is intended to provide an objective measure of a patient's level of impairment. The NIHSS can be difficult to complete with patients who have limited communication or previous neurologic symptoms. For this reason, providers must score each item based on how the patient performs in the present moment and not based on the patient's history. A higher score on the NIHSS indicates a more severe stroke.

Research shows that NIHSS results correlate with infarction size confirmed by diagnostic imaging. Providers should know that the newer, more simplified version of the NIHSS holds higher interrater reliability for its accuracy in a wider range of patients, but the standard NIHSS format is more readily available.

Cincinnati Prehospital Stroke Scale (CPSS)

This simplistic stroke scale is intended for use by emergency providers who first make contact with someone who has potentially experienced a stroke. The CPSS involves providers rating patients as normal or abnormal in three items: speech, facial droop, and arm drift. This is a good way to determine the likelihood of stroke and inform the actions of EMS and nursing staff. This measure is not ideal for patients who are already hospitalized, since other more sensitive tests can be performed. This test is equivalent to the Face Arm Speech Test (FAST), which has all the same components. The FAST and CPSS have been recognized for their ability to accurately determine the presence of a stroke in the early stages. These scores have been shown to later align with a doctor's official diagnosis of stroke.

Los Angeles Prehospital Stroke Screen (LAPSS)

The LAPSS is a similar test that helps providers identify a stroke early on. This is a bit more detailed than the CPSS, as it includes basic ratings for a person's past mobility level, presence of seizures, current blood glucose level, facial asymmetry, grip, and arm strength. If a patient scores 'yes' on all nine items, they have met the screening criteria for stroke and providers should follow the appropriate treatment algorithm.

Recognition of Stroke in The Emergency Room (ROSIER)

This is another test that helps providers determine the difference between acute stroke and other similar neurological conditions or symptoms. This test addresses asymmetric muscle weakness, loss of consciousness, speech changes, and visual field impairments. Similar to other tests used in emergency circumstances, the ROSIER is intended to be rapid and give a definitive answer to inform treatment.

Arnadottir OT-ADL Neurobehavioral Evaluation (A-ONE)

The previous tests we discussed are more often used by physicians and nurses, but the A-ONE is a stroke-specific OT evaluation. The A-ONE uses functional observation to measure the impact of any neurobehavioral condition (stroke included) on a person's ability to complete ADLs. This standardized assessment is aptly beneficial for therapy providers since it identifies the level of assistance someone with a stroke needs and notes the type and severity of their deficits. This test covers all basic ADLs along with transfers and communication. Research shows that A-ONE has excellent test-retest and interrater reliability.

Assessment of Motor and Process Skills (AMPS)

The AMPS is another therapy-specific standardized assessment that is also based on observation of ADL completion. Motor subsections include getting and holding objects, body positioning, sustaining performance, and moving oneself and objects around them. Process domains include adapting performance, applying knowledge, sustaining performance, temporal organization, and organizing space and objects around them. Each item is scored on a scale of 1 to 6, with 1 being no problems with completion and 6 being inordinate difficulty with completion.

Chedoke Arm and Hand Activity Inventory (CAHAI)

This is another therapy-specific assessment that determines the function of a patient's upper extremities after a stroke. This is a good measure to go along with a more generalized stroke test called the Chedoke-McMaster Stroke Assessment. There are newer versions that have been somewhat modified, but the original version consists of 13 items: dialing 911, drawing a line with a ruler, pouring a glass of water, opening a jar of coffee, wringing out a washcloth, buttoning five buttons, cleaning eyeglasses, zipping a zipper, cutting medium resistance putty, drying the back with a towel, putting toothpaste on a toothbrush, carrying a bag up the stairs, and placing a container on a table. There are four simple items, four moderately difficult items, and four difficult items. Patients are scored using a scale similar to that of the Functional Independence Measure (FIM), where 1 is total assistance and 7 is total independence. This test is also sensitive in that it gives therapists the ability to score patients based on the exact location of their affected limb/hand during the task. For example, more points are given if the patient holds the zipper pull rather than the zipper itself.

Disabilities of the Arm, Shoulder, and Hand (DASH)

The DASH is a self-report assessment tool that is used to measure upper extremity function in individuals with a range of orthopedic conditions. It can also be used for stroke patients since it has good validity, but it should be noted that test-retest reliability for this population is low. The DASH consists of 30 items. For the first 21 items, patients will rate their ability to perform the test as either no difficulty, mild difficulty, moderate difficulty, severe difficulty, or unable if they cannot perform the task at all. This account is intended to gauge the patient's performance of these tasks in the past week. For the remaining 9 items, patients are asked more general questions such as how much their extremity has impacted their social life or work negatively in the past week and the presence of symptoms such as paresthesias, weakness, and pain. There are also optional work and sports/arts modules for patients with more specific concerns in those areas. The higher the score, the greater the level of impairment that is present.

Fugl-Meyer Assessment of Sensorimotor Recovery After Stroke (FMA)

This is another stroke-specific assessment that providers can use to measure motion, joint pain, balance, and sensory function. There are some seated balance tests and some standing balance tests, so this test caters to both higher-functioning and lower-

functioning individuals. Many providers do not prefer this assessment, since it takes around 40 minutes to complete (and sometimes longer for individuals with communication difficulties). Individuals who score between 95 and 99 are considered to have slight impairments, also known as slight motor incoordination. Those who score between 85 and 94 are known as having moderate hemiparesis. Patients who receive a score between 50 and 84 usually have marked deficits characterized by hemiplegia. Anyone who scores less than 50 has had a severe stroke and corresponding limitations.

Motor Evaluation Scale for Upper Extremity in Stroke Patients (MESUPES)

This is another stroke sensitive assessment that measures a patient's motion in the affected arm and hand. This measure asks providers to encourage normal movement as much as possible, which can be done by comparing the affected arm to the opposite side of the body. The MESUPES also emphasizes specific instructions to assist patients in this process. Patients are given a score of zero if tone prevents them from achieving the starting position or tolerating passive movement. Patients are scored one if their tone adjusts to at least part of the required movement. Patients will receive a score of two if providers observe a normal muscle contraction for at least one portion of the movement. Providers can give patients a three if they perform part of the movement normally and a four if they go through the entire movement normally but do so very slowly. The patients who receive a five will be able to complete full movements normally and at a regular pace.

Postural Assessment Scale for Stroke Patients (PASS)

The PASS consists of 12 items that help providers assess a patient's postural control. Patients are scored between 0 and 3 on the following items:

- Standing without support
- Sitting without support
- Standing with support
- Standing on affected leg
- Standing on unaffected leg
- Rolling from supine to affected side

- Rolling from supine to unaffected side
- Supine to sit
- Sit to supine
- Sit to stand
- Stand to sit
- Picking up an object from the floor while standing

The PASS also has two alternate versions, one that focuses only on trunk control and a short form. Both of these versions have 5 items. The PASS was found to have excellent validity for chronic stroke and adequate to excellent test-retest reliability for cases of acute and subacute stroke. Research also shows that this assessment is responsive in regards to the items it tests.

Stroke Specific Quality of Life Scale (SS-QOL)

This is a stroke-related assessment that is also self-report and focuses more on the mental health and well-being of patients who have experienced a stroke. The SS-QOL also does a good job of exploring certain client factors and skill areas that are commonly a concern with stroke, since they can have an impact on a person's quality of life. Research has proven this measure to be valid and consistent for adult and older adults patients who have recently experienced a stroke. The SS-QOL addresses areas such as vision, social roles, communication/language, self-care, familial roles, energy levels, work, mobility, mentation, mood, personality, and upper extremity functioning. Patients are asked to rate each item based on how much assistance they need: total help, a lot of help, some help, a little help, or no help.

There are also other assessments that do not pertain directly to stroke but can help therapists assess specific skill areas such as balance, coordination, and activity engagement:

Activities-Specific Balance Confidence Scale (ABC Scale): This is a self-report that asks patients to rate how comfortable they are with keeping their balance during certain activities.

Activity Card Sort (ACS): The ACS uses pictures to help patients identify important aspects of their occupational histories, and can be helpful for stroke patients with communication deficits. Therapists can also use the ACS to inform treatment planning through the incorporation of meaningful, person-centered activities.

Behavioral Inattention Test: This helps therapists detect any signs of visual neglect, which commonly occurs as a result of a stroke. This used to be called the Rivermead Behavioral Inattention Test.

Berg Balance Test (BBS): The BBS helps therapists see a patient's ability to safely keep their balance while performing a variety of mobility-related tasks.

Double Letter Cancellation Test (DLCT): This test helps therapists determine if patients have any visual scanning deficits and, if so, the severity of those impairments. The DLCT involves scanning a page with 6 lines of 52 letters to find as many occurrences of two letters as possible.

Executive Function Performance Test (EFPT): This test measures a patient's cognition by determining what executive functions are impaired, if a patient can function independently, and how much assistance they need for basic living tasks such as medication management, paying bills, cooking, and phone use.

Jebsen Hand Function Test (JHFT): This test is a generalized way to measure fine and gross motor function of the hand. The JHFT was initially developed for use with those who have spinal cord injury, but it can now be used with patients who have a stroke, brain injuries, arthritis, and other concerns.

Mini-Mental Status Exam (MMSE): This test gives providers a quick snapshot of a patient's skills in the areas of orientation, language, visual-spatial, attention, and memory. The MMSE can be used for a variety of conditions. In terms of stroke, research shows this test is most useful in testing cognition in those moderate deficits around 1 month after a CVA but is not a suitable way to determine a patient's long-term cognitive functions.

Montreal Cognitive Assessment (MoCA): The MoCA was originally developed to help detect and diagnose forms of dementia, but research supports the use of this test to determine the cognitive function of patients with mild to moderate stroke.

Motor-Free Visual Perception Test (MVPT): The MVPT can be used to test five domains of visual function, and is commonly used on stroke patients and those who have experienced TBIs. This test is ideal for both children and adults.

Nine Hole Peg Test (NHPT): This test involves placing small pegs into corresponding holes to test finger dexterity. The NHPT can be used across many diagnostic categories. When used on stroke patients, therapists should test the unaffected arm followed by the affected arm, then compare the two scores for reference.

Timed Up and Go (TUG): The TUG is a simple test that measures how long it takes for someone to get up from a chair, ambulate about 10 feet, and sit in another chair. This can be used for anyone who has mobility difficulties, including those with stroke. Therapists who use the TUG with stroke patients should make note of turning direction since results are impacted depending on what side the patient turns to.

Section 7 Personal Reflection

What other general ambulation or mobility-based tests might be used to assess a patient who has experienced a stroke?

Section 7 Key Words

Behavioral inattention: The inability to attend to objects in one visual field; also known as visual neglect

Cancellation test: A test that requires patients to scan multiple objects and mark off (or cancel) certain targets as per the instructions

Executive functions: Higher-level cognitive processes that involve the following skills: planning, self-monitoring/self-awareness, working memory, time management, organization, self-control, and flexible thinking

Functional Independence Measure: One of the most basic and widely used standardized assessments that requires providers to give patients basic ratings on 18 self-care tasks; ratings are between 1 and 7, and are based on the amount of assistance patients need to complete each task; a score of 1 is given to patients who need total assistance and a score of 7 is assigned to patients who are entirely independent; this measure is also known as the FIM

Interrater reliability: The consistency of results and interpretations obtained from multiple providers who have completed the same standardized assessment; in order to be used with good results, a standardized assessment should have strong (.80 to .90) or almost perfect (above .90) interrater reliability

Mentation: A person's cognitive abilities and mental capacity made up of several functions

Temporal organization: A form of organization that exists for only a predefined and finite amount of time

Test-retest reliability: The consistency of results and interpretations obtained from multiple retests of the same standardized assessment; in order to be used with good results, an assessment's test-retest reliability should be good (.40 to .75) or excellent (above .75)

Treatment algorithm: A reference that helps providers determine what line of treatment is appropriate for patients with certain signs, symptoms, or test results

Validity: The accuracy of a standardized assessment that proves the test always measures what it says it does

Section 8: Occupational Therapy Treatment for Stroke

47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,64,65,66,67,68,69,70,71,72,73,74,75,76,77

Before therapists begin to plan treatment, they must take into consideration the phase of stroke rehab a patient is in. After that, they will use the appropriate frames of reference to inform their practice. The foundations of the frame of reference can guide a therapist in creating exercises and activities that benefit each patient.

Acute phase: 2 weeks after stroke

Sub-acute phase: 3-11 weeks after stroke; this is when the most changes occur

Early chronic phase: 12-24 weeks after stroke

Chronic phase: 24 weeks or more after stroke

During the acute phase, positioning is crucial to prevent shoulder subluxation and contractures while minimizing pain. There is varied evidence on exactly what positions are best for recovery. Some studies note that laying flat will improve cerebral blood flow, but this might increase the risk of aspiration. Other research notes that elevating the patient's head can reduce intracranial pressure in cases of large stroke. Some providers opt for side-lying positioning to reduce the risk of aspiration. If this is recommended by the patient's doctor, therapists can help patients lie on their affected side so they can still use their unaffected limb.

Early passive range of motion can help prevent shoulder subluxation. Therapists should also position pillows in the patient's lap and on their arm rest to ensure the shoulder is supported in neutral while the elbow is at 90 degrees. This will prevent gravity from pulling the shoulder downward and out of the socket. Specialized slings such as the GivMohr provide support from the hand. These are best for someone with flaccidity and not those with excessive flexor tone.

Most of the FORs below have structured treatment recommendations based on the phase the patient is in.

Brunnstrom Movement Therapy

Brunnstrom Movement Therapy focuses on the emergence of primitive reflexes and the presence of muscle synergies, which are a normal part of the recovery process after a stroke. This frame of reference encourages therapists to utilize these reflexes and synergies to help patients engage better in both therapeutic and functional activities. Brunnstrom identifies six stages that are crucial to the recovery process.

In Stage 1, therapists should focus on passive range of motion (PROM). The act of simply completing the motion, even though there is no active movement, sends signals from the skin and muscles of the affected extremity to the brain. Stage 2 also has a heavy emphasis on passive range of motion, but patients are also encouraged to complete active-assisted range of motion (AAROM) if some motion has returned to the affected extremity.

Passive range of motion and active-assisted range of motion continues to be important in Stage 3, but this is also when flexor and extensor synergy will come into play. Therapists should instruct patients to think of moving their shoulder in an attempt to move their elbow in an attempt to move their hand. This also utilizes the concept of

achieving control over your proximal muscles before you can sufficiently move your distal muscles. In Stage 4, therapists should continue with active-assisted range of motion and progress to active range of motion. This involves less of a focus on moving large muscle groups and more on isolating individual muscles. These activities counter a patient's muscle synergies, which help with neural reorganization and activate other parts of the brain.

In Stage 5, patients will begin progressive strengthening activities to build on the active motion they have built. Patients who have reached Stage 6 will continue to participate in strengthening activities along with exercises that address coordination skills, especially those that encourage bilateral integration.

This theory and its stages date back to the 1960s when it was developed by a physical therapist specializing in stroke rehabilitation. Some people attempt to discredit traditional approaches such as Brunnstrom since they were originally based on the premise that strokes always resulted in spasticity. We now know this is not the case, and the theory has been modified quite a bit since that time. Despite this, there remains a relatively strong basis of evidence supporting Brunnstrom over the years.

One study analyzed the muscle synergies present in a sample of stroke patients and found a strong correlation with the sequence set forth by Brunnstrom. A separate study measured the effectiveness of the Brunnstrom stages and determined that they were a good reflection of a person's upper extremity function and overall motor control. One dated piece of research compared the Brunnstrom stages to the levels of reflex responsiveness and spasticity when measured by the Modified Ashworth Scale (MAS). This study found that the Brunnstrom stages were moderately correlated with results of reflex responsiveness, and strongly correlated with the scores from the MAS. This proves the reliability of the Brunnstrom stages as a measure to guide stroke treatment.

Brunnstrom has also proven a better measure than other theories that govern stroke rehabilitation. A large study compared a group receiving Brunnstrom hand manipulation to a group whose intervention was based on the concept of motor relearning. Results showed that, while both groups experienced functional gains, the group receiving Brunnstrom therapy demonstrated far greater scores on standardized assessments.

Compensatory Frame of Reference

The Compensatory Frame of Reference is ideal if an individual who experiences a stroke has undergone extensive rehabilitation and still struggles to complete certain basic or meaningful activities. This frame of reference is a good fit for patients who can benefit from compensatory strategies to increase their performance and independence in certain skill areas.

Therapists might teach patients new ways of doing activities after a stroke, but assistive devices and adaptive equipment are often a large part of compensatory approaches in rehabilitation. This can include:

- Sock aids
- Reachers
- Dressing sticks
- Zipper pull
- Button hook
- Elastic shoelaces
- Long-handled shoe horns
- Universal cuffs
- Pencil grips
- Page turners
- Modified nail clippers
- Rocker knives
- Swivel spoons
- Electric can openers
- Hospital beds
- Shower chairs

- Tub benches
- 3-in-1 commodes
- Lift chairs
- Walkers
- Rollators
- Wheelchairs
- Mobility scooters
- Augmentative and alternative communication devices (AAC)
- Dictation software

These options are usually ideal for those who have some motor impairments (such as weakness or incoordination) but still possess enough strength and motion to operate the equipment. Therapists also must be mindful that patients need to be trained on the use of these devices, so they should have enough cognition to retain that information and safely use the device(s).

Neurodevelopmental Treatment (NDT)

This is a traditional approach to stroke rehab, which involves normalizing tone, regaining motor control, improving posture, and making more precise, intentional movements. NDT involves utilizing key points of control on the body to inhibit or facilitate certain movements. The focus is on the pelvis and the shoulders, since they play a large role in someone's posture. In some countries, NDT is called the Bobath Approach. NDT can be used beginning in the acute phase of stroke. Therapists must follow the main principles of NDT, including:

- Involving meaningful activities in the retraining process
- Not imposing normal movement on joints with poor alignment
- Using hands to inhibit tone and facilitate normal movement
- Using hands to foster appropriate placement to achieve proper positioning
    - Wide base of support

- Alignment of all body segments
- Muscle activation is timed properly during functional activities
- Shifting weight in all planes

There is varying evidence supporting the use of NDT for stroke patients. A dated systematic review compared NDT to other traditional treatment approaches and found that it was no more or less effective than methods such as Brunnstrom. Another dated study compared a group of patients in a rehab unit who received NDT to another institutionalized group who received no treatment. Results showed that neither group demonstrated significant improvements in the areas of quality-of-life and functional performance as measured by the Barthel Index. A similar, but more recent study compared NDT to other conventional stroke rehab approaches. They also found no significant improvements in patients who received this treatment.

One piece of research discussed the use of NDT approaches to specifically target quadriceps muscle thickness and functional use in stroke patients. Results showed that, when high-intensity NDT was used in the acute phases of the stroke, these approaches yielded functional improvements. A recent systematic review focused only on the effectiveness of NDT/Bobath determined that this approach was no more effective than other traditional neurological techniques used for stroke rehabilitation. This study also emphasized the scarcity of evidence surrounding the use of NDT.

Proprioceptive Neuromuscular Facilitation (PNF)

PNF focuses on purposeful, intricate stretches designed to improve the connection between the muscles and the brain. Therapists can use PNF to improve muscle thickness (this is helpful in cases of muscle atrophy resulting from a stroke), gait, and dynamic balance. In cases of acute stroke, diagonal patterns assist in reeducating the body to engage in normal movements of the hip and shoulder complexes:

D1 Flexion: flexion, adduction, external rotation

D2 Flexion: flexion, abduction, external rotation

D1 Extension: extension, adduction, internal rotation

D2 Extension: extension, abduction, internal rotation

Therapists can also utilize similar diagonals for the scapula and pelvis:

D1 Elevation: Anterior elevation

D2 Elevation: Posterior elevation

D2 Depression: Anterior depression

D1 Depression: Posterior depression

In sub-acute and chronic cases of stroke, therapists can guide patients in regularly completing a series of three stretches to increase flexibility and improve range-of-motion. PNF consists of three main stretches: hold-relax, contract-relax, and hold-relax with an agonist contraction. Therapists can guide patients through the hold-relax stretch using the following steps:

1. Therapists should passively stretch the patient's muscle and hold it for 5 seconds.
2. Then, instruct the patient to contract the muscle without moving from their original position. This triggers the reflex that allows for a deeper stretch.
3. Within 6-10 seconds, instruct the patient to relax then exhale while stretching again.
4. Bring to the patient's attention that the second stretch was deeper and ask them if/how that felt different from the first.

To complete the contract-relax stretch, therapists should follow these steps:

1. Therapists should passively stretch the patient's muscle and hold it for 5 seconds.
2. Then, instruct the patient to contract the muscle while attempting to move from their original position. This contraction is called isotonic stretching, which triggers the reflex that allows for a deeper stretch.
3. Within 6-10 seconds, instruct the patient to relax then exhale while stretching again.
4. Bring to the patient's attention that the second stretch was deeper and ask them if/how that felt different from the first.

The hold-relax-contract stretch is also similar with one main exception:

1. Therapists should passively stretch the patient's muscle and hold it for 5 seconds.
2. Then, instruct the patient to contract the muscle and push against the stretch. This triggers the reflex that allows for a deeper stretch.
3. The patient should continue pushing against the stretch while you instruct them to continue pushing to move the joint.
4. Bring to the patient's attention that the second stretch was deeper and ask them if/how that felt different from the first.

It is important that therapists do not use maximum force when aiding in the stretching process, since this can injure the muscles and soft tissue. This is especially true of smaller muscle groups.

Research supports the use of PNF in improving overall flexibility and motion, especially when it incorporates the use of functional activities. One study looked at the impact of PNF on brain-derived neurotrophic factor (BDNF), which plays a large part in neuroplasticity and brain recovery after a major injury. The results were particularly impactful and showed that PNF was one of the only treatment methods that effectively improved a stroke patient's level of functioning and BDNF. These outcomes were noted across the entire sample, regardless of the stroke type, severity, and risk factors the patient carried.

The benefits of PNF don't end with neuromuscular rehabilitation in stroke patients. Other research looked at the impact of PNF on cardiopulmonary function, which is commonly affected by ischemic strokes. This study used spirometry to measure the respiratory levels before and after patients received just a single session of PNF. These spirometry measures were compared to those of a group who did not receive PNF. Those in the PNF group demonstrated an increase in FEV1 scores, which indicates how much air someone can expel from their lungs in one second, along with an increase in FVC%, which is the total amount of air exhaled during spirometry. These results are a strong indicator of PNF's potential utility for cardiopulmonary rehab in stroke patients.

Other research focused on motor capacity showed that PNF combined with kinesiotape on the foot resulted in improved ankle dorsiflexion and static balance of those with chronic stroke when compared to ankle kinesiotape alone. There is also research on the joint use of virtual reality and PNF techniques. Outcomes showed that the combined use

of these modalities was more beneficial than when they are used alone on chronic stroke patients.

There are even more studies focused on the combined use of PNF with other traditional modalities. One piece of research focused on the use of neuromuscular functional electrostimulation (NFES) combined with PNF with ischemic stroke patients from the acute to the chronic phase. The study consisted of a group that received both modalities and a group that received only PNF. Results showed that the combined group demonstrated improved antagonistic muscle function when compared to the group that received PNF alone.

Rood Sensorimotor Training

The Rood approach focuses on the role of the sensory systems in rehabilitating a person's motor skills. Rood involves activating or deactivating sensory receptors that govern somatic and autonomic functions. Treatments based on the Rood approach involve repetitive, purposeful movements that normalize tone and follow the ontogenic developmental sequence. Therapists can facilitate this type of movement by guiding patients through the following motions in this order: supine withdrawal, rolling over, pivot-prone, neck co-contraction, prone on elbows, quadruped, standing, and walking.

If increased tone arises throughout any phase of the treatment process, therapists should use inhibitory techniques including:

- Deep pressure
- Slow rolling
- Gentle stroking
- Thermal stimulation
- Light joint compression
- Pressure to the tendons
- Maintained stretch
- Gentle rocking, shaking according to ontogenic stages

If patients present with decreased tone, or flaccidity, therapists can use facilitatory techniques including:

- Fast brushing
- Icing
- Light touch
- Intrinsic stretching
- Heavy joint compression
- Tapping
- Vestibular stimulation
- Therapeutic vibration
- Resistance
- Inversion

Overall, there is much less evidence on Rood approaches as compared to PNF and even other traditional treatments. However, some evidence supports the use of Rood techniques. One study found the use of Rood was especially effective in improving the self-care abilities of individuals who have experienced a hemorrhagic stroke. This is notable because most studies on stroke rehabilitation focus on patients with ischemic stroke. Another study acknowledges the impact that sensory functioning has on motor control, which emphasizes the importance of Rood sensorimotor techniques for patients with a range of deficits. Other research looked at the efficacy of a haptic-based system using Rood approaches. Results found that these systems provided enough stimulation to contribute to reflexive motor induction, which aids in the upper limb rehabilitation process.

Biofeedback

This is another sensory-based treatment that can help stroke patients. Using electromyography (EMG), therapists can track the electrical charge of a patient's muscle fibers. This is done by placing several small needles called electrodes on the skin and into the muscle fibers. Individuals are asked to slightly, then forcefully contract the

muscle that is being measured. Muscles will not give off any electrical signals when at rest, so there should be minimal information to start. The signals should then increase when an individual tenses and remain this way until the muscle is relaxed again. This method is used to increase a patient's awareness of their motor control so they can employ certain therapeutic techniques (practiced during sessions) to encourage more active motion.

Since this form of biofeedback requires active movement, it's best suited for individuals in the subacute or chronic phases of stroke. In addition to encouraging more active motion, EMG biofeedback can also be used in other settings to help patients become more aware of muscle tension and promote relaxation.

One systematic review cites a large amount of literature that notes positive effects from EMG-based biofeedback for individuals with hemiparesis. There was a lot of variation regarding sensor placement, but many of the studies focused on EMG to improve gait rather than upper body function. There is some research that looks at the usage of visual biofeedback to improve outcomes in stroke rehabilitation. Results from this showed that this treatment was effective in improving intermuscular coherence (leading to improved synchronization) of the quadriceps femoris. Another study looked at the impact of audio and visual feedback on gait. Findings showed an increase in anterior ground reaction force while patients walked on the paretic limb compared to the force without biofeedback.

There is not much research surrounding the use of biofeedback on the upper extremity of those with stroke, but one study did suggest the use of EMG biofeedback for dysphagia in stroke patients. Researchers emphasized the need for clinicians to utilize technology to provide cues for motor relearning and body awareness.

Motor Relearning

Motor relearning, in combination with task-oriented functional training has long been at the center of stroke rehabilitation. This theory involves the use of biomechanics, cognitive psychology, and neuroscience to reteach the brain basic movements after a neurological injury. There are several principles crucial to the practice of motor relearning:

- Massed practice

- Spaced or distributed practice (e.g. 10 repetitions, a 5-minute rest break, and 10 more repetitions)
- Variable practice across different contexts
- Task-specific practice
- Graded difficulty
- Goal-oriented practice
- Rhythmic cueing
- Multisensory stimulation
- Clear feedback

Many studies have found motor learning to be an effective way to improve functional gains in stroke patients. Some research compared the effects of motor relearning to those of mirror therapy. Results found that patients who received motor learning therapy showed significant improvements in upper arm function, hand function, and advanced hand function.

Other Approaches

Another less traditional approach is constraint-induced movement therapy (CIMT). This involves exclusive use of the impaired arm to speed up motor recovery while the unaffected arm is restrained. There are few research studies on CIMT and stroke recovery. The research that does exist cites limited motor improvement following CIMT. There is more research that connects CIMT in animals to neuronal recovery, but there is not much carryover for usage in acute stroke.

Functional Electrical Stimulation (FES) and Neuromuscular Electrical Stimulation (NMES) are forms of electrical stimulation used specifically for stroke patients. NMES involves stimulating intact nerves to activate affected nerves. FES uses a similar mechanism but focuses on stimulating these nerves during functional activities. Both of these modalities can be used as soon as patients demonstrate an active muscle contraction, which is often in the subacute phase. It's best to begin with NMES and move to FES once the patient has made some progress. One piece of research showed that a 6-week program of FES yielded improvements in functional participation and quality of performance in

those with all types of stroke. Other studies have shown that FES combined with biofeedback was particularly effective in improving gait, even after a single session. FES and NMES have also been proven effective in improving motion of the upper extremity after ischemic and hemorrhagic strokes. Additional studies have gone on to demonstrate self-care improvements in the affected arm as a result of FES. NMES has also been combined with other modalities to rehabilitate stroke patients with dysphagia. One study found that NMES and transcranial magnetic stimulation (TMS) combined to produce higher cortical activity and better swallow function compared to NMES alone.

Mirror therapy involves the use of a mirror placed between the two arms so it provides the patient with a reflection of the unaffected arm. This gives patients the visual effect of the opposite arm (the affected arm) moving normally just as the unaffected side is. This assists with the brain's perception of the body's recovery. Evidence suggests that mirror therapy is best when used in combination with more traditional approaches, but that it does assist with pain, ADL function, and upper extremity use. Other research supports the idea that mirror therapy is most beneficial during the subacute phase of stroke when combined with action observation to assist with motor planning. Similarly, when mirror therapy is combined with gesture recognition to aid in executing tasks, patients with subacute and chronic stroke showed improvements in upper extremity use, quality-of-life, and depression. Other research suggests that working memory and top-down attention play a role in the success of mirror therapy, so this is a potential consideration for therapists to be mindful of. There are few studies done on the use of virtual mirrors for this treatment. One study does not recommend using it in practice, since there is not enough evidence to prove the absence of adverse effects. Another study notes that chronic stroke patients tolerated treatment well when mirror therapy was combined with virtual reality devices, but this does not speak to its effectiveness.

Section 8 Personal Reflection

What treatment modalities might produce even better outcomes when used in combination?

Section 8 Key Words

Active-assisted range of motion: When someone receives partial assistance to complete a movement, either from the therapist or from their other extremity

Flexor synergy: A movement pattern that involves external rotation of the shoulder, elbow flexion, and forearm supination

Frame of reference: A theoretical basis that uses various approaches to structure treatment

Extensor synergy: A movement pattern that involves internal rotation of the shoulder, elbow extension, and forearm pronation

Muscle synergies: Movements that result from multiple muscle contractions triggered at once

Spirometry: A respiratory test that measures the quantity and quality of breaths

Section 9: Case Study

An OT does an evaluation on a 40-year-old male who just got admitted to a skilled nursing facility after being diagnosed with an ischemic stroke. He presents with left-sided weakness, homonymous hemianopsia, and impaired sensation on the left side of the body. He is also reporting pain in the left shoulder that worsens over the course of the day. His insight is intact and nursing reports that he is able to ambulate with stand-by assistance. His stroke occurred 7 days ago and this is the first time he has received OT since that time.

1. What part of the brain was likely impacted by this patient's stroke?
2. What might be an appropriate standardized assessment for the OT to perform on this patient?
3. What is one of the first interventions an occupational therapist should implement for this patient?

Section 10: Case Study Review

This section will review the case studies that were previously presented. Responses will guide the clinician through a discussion of potential answers as well as encourage reflection.

1. What part of the brain was likely impacted by this patient's stroke?

Based on the patient's main symptoms, he likely experienced a stroke secondary to a blockage in the right portion of his middle cerebral artery (MCA).

2. What might be an appropriate standardized assessment for this patient?

   This patient would benefit from taking the Fugl-Meyer, since it addresses joint motion, pain, sensation, and balance. Since ambulation and transfers are not a major concern for this patient, an assessment that focuses on the upper body along with pain is best. Due to the patient's intact insight, he might also benefit from the DASH since he can self-report how his impairments (including pain) are impacting him.

3. What is one of the first interventions an occupational therapist should implement for this patient?

   Because the patient is reporting shoulder pain, the OT should focus first on positioning. He is at risk of or may already be experiencing shoulder subluxation. The therapist should assess the glenohumeral joint as part of their evaluation to determine if this is the case. Regardless of whether subluxation is present, the OT should provide supportive positioning for the patient by placing pillows under and next to the shoulder to keep the elbow at 90 degrees. If the pillows are not enough support, the OT should look into fitting the patient for a custom sling.

Section 11: Case Study

A 27-year-old female was just diagnosed with an AVM rupture in the frontal lobe 2 days ago. She presents with lability and concerns related to problem-solving, judgment, and motor planning. Her gross motor control is also impaired. Doctors are still discussing her case and how to go about treatment, both surgically and pharmacologically. In the meantime, OT has been asked to see her and assist with some presenting symptoms.

1. What surgical procedure might this patient be a candidate for?
2. What standardized assessment should the OT complete?
3. What OT interventions might be appropriate before the patient has surgery?

Section 12: Case Study Review

This section will review the case studies that were previously presented. Responses will guide the clinician through a discussion of potential answers as well as encourage reflection.

1. What surgical procedure might this patient be a candidate for?

   This patient might have been recommended for a cranioplasty so doctors can access the remaining AVM, seal it off, and remove it. This patient might also have undergone endovascular coiling to insert a coil in the AVM's blood supply, which cuts it off. Another potential procedure is endovascular embolization, which involves placing glue or another material in the AVM itself to stop it from growing.

2. What standardized assessment should the OT complete?

   Since the patient has not yet been surgically treated, it's possible that her presenting symptoms will change in the next several days. Taking this into consideration along with the location of the rupture, a therapist should complete a test of cognition that gives a snapshot of the patient's present abilities. The best assessment for this is likely the Mini Mental Status Exam, since it is short and gives a sense of the patient's memory, attention, orientation, and visual-spatial skills. This can be used as a point of reference after the patient has surgery. Though the patient also has concerns related to gross motor control, it might be best to defer formal testing in that area until after she has surgery, since she is still at risk of another rupture until the AVM is removed.

3. What OT interventions might be appropriate before the patient has surgery?

   Since this patient has impaired judgment and problem-solving, she might demonstrate some unsafe behaviors that place her at risk of further injury. The OT should recommend bed rails to keep her from getting out of bed without supervision. If any other immediate safety concerns arise, these become the first priority and should be addressed. Other interventions should be implemented after the patient has surgery.

Section 13: Case Study

A 50-year-old male sustained a hemorrhagic cerebellar stroke 10 days ago. He was last seen by OT 2 days ago for an evaluation, at which time he demonstrated headaches, loss of balance, ataxia, tremors, and slurred speech. The OT completed the Berg Balance Scale and the patient scored 25, which places him at a moderate risk of falling. There was no standardized testing completed on cognition, but the cognitive portion of the evaluation revealed no major concerns. His insight is intact and he is beginning to demonstrate some depression regarding his impairments. This patient was also just diagnosed with acute vestibular syndrome.

1. What other symptoms will this patient likely present with as a result of his new diagnosis?

2. How can the OT best address this patient's concerns?

Section 14: Case Study Review

This section will review the case studies that were previously presented. Responses will guide the clinician through a discussion of potential answers as well as encourage reflection.

1. What other symptoms will this patient likely present with as a result of his new diagnosis?

   As a result of acute vestibular syndrome, this patient will present with dysarthria, dysphagia, emotional instability, and tetraplegia.

2. How can the OT best address this patient's concerns?

   Since this patient is demonstrating some depressive symptoms, the OT should consider a referral to a psychologist or a psychiatrist. Psychiatric medication might not be the best option due to side effects that worsen his vestibular symptoms, but counseling could help. The OT can also address emotion regulation, coping, behavior management, and adjustment to disability via psychoeducation and meaningful activities.

Section 15: Case Study

A 79-year-old female experienced an ischemic stroke that led to a fall down 2 stairs in her home. Her husband was home at the time and found her an hour later. The patient did not sustain any physical injuries in the fall aside from minor cuts and scrapes. Emergency medical care was administered as soon as she got to the hospital. Two days later, she is seen by OT and presents as non-verbal and unable to tolerate a normal diet due to severe dysphagia. She briefly nods but does not otherwise try to communicate. She refuses to attempt transfer training and will also not ambulate. Prior to the stroke, she was independent other than getting intermittent help with socks and shoes.

1. How can the OT get this patient to engage in a complete evaluation?
2. What early steps might the OT need to take to ensure this patient's safety?
3. What might be an appropriate discharge plan for this patient?

Section 16: Case Study Review

This section will review the case studies that were previously presented. Responses will guide the clinician through a discussion of potential answers as well as encourage reflection.

1. How can the OT get this patient to engage in a complete evaluation?

   The OT should first talk with the patient's husband and other family members to determine the patient's interests. The OT can incorporate these into the evaluation to try and build a rapport with the patient. The OT should then try to engage the patient in some basic self-care activities to determine her level of functioning. If the patient still does not engage, the OT can use some reports from nursing staff regarding the patient's ADLs or join in on one of these sessions to get a better idea of the patient's abilities.

2. What early steps might the OT need to take to ensure this patient's safety?

   The OT should be sure the patient has all they need within arm's reach of them at all times. Since this patient is reluctant to transfer, she is also likely afraid of ambulating or adjusting in any way. This means she is at risk for pressure ulcers, so the OT should also focus on positioning and implement a rotating schedule

that all nursing staff are aware of. If one has not been made already, the OT should get a speech-language pathology referral to address the patient's dysphagia and communication deficits. This can also help the therapist interact with the patient regarding her ADL abilities.

3. What might be an appropriate discharge plan for this patient?

   At the current moment, this patient can only be discharged if a home evaluation is completed to decide if the basic layout of the house is manageable. If this is the case, the patient may be able to live at home with 24-hour-care and durable medical equipment including a hospital bed, feeding tube, and 3-in-1 commode (potentially a catheter if she continues to refuse to ambulate to the bathroom). In order for this to be a viable option, she will likely need other support in place. Her financial and social situation should also be assessed to determine whether home or a long-term care setting is the best choice.

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