CHAPTER 5

Stroke

OVERVIEW OF NONTRAUMATIC BRAIN DAMAGE

The brain, like any other tissue, requires oxygen to function. Oxygen is carried in blood by hemoglobin. When there is too little oxygen in the blood supply (**hypoxia**), brain function is altered. When there is no oxygen available (**anoxia**), brain tissue may be permanently damaged resulting in neurological manifestations.

Generally, brain damage is classified as one of two types:

- Traumatic brain injury
- Nontraumatic brain damage

Whereas *traumatic brain injury* refers to injury to the brain from an external force, *nontraumatic brain damage* refers to conditions that restrict or interfere with blood and oxygen reaching parts of the brain, consequently causing damage to brain tissue. Examples of conditions that can cause nontraumatic brain injury are choking, near-drowning, or carbon monoxide poisoning; infections, such as meningitis and encephalitis; occlusion of a blood vessel supplying the brain by a blood clot; rupture of a weakened blood vessel in the brain; and congenital structural aberrations of blood vessels in the brain.

Although the manifestations of nontraumatic brain damage can be similar to those experienced with traumatic brain injury, often nontraumatic brain damage is associated with other chronic underlying conditions, which, unless adequately managed, can cause additional nontraumatic brain damage. One of the most common causes of nontraumatic brain damage is *stroke*.

OVERVIEW OF STROKE

Stroke (also called *cerebral vascular accident* [*CVA*]) is one of the leading causes of incapacitation in the United States (Zivin, 2012b). It is caused by decreased blood flow, and subsequent inadequate oxygen supply to part of the brain leading to tissue damage, which causes neurological manifestations that can affect a number of body functions. Stroke is related to a number of other chronic conditions, such as cardiac disease, **arteriosclerosis** (*ischemic vascular disease*), **hypertension** (high blood pressure), and diabetes (Greenberg, 2006).

Other risk factors for stroke include smoking, obesity, physical inactivity, heavy alcohol use, and use of illicit drugs, especially cocaine and amphetamines (Gebel, 2007; Suarez, Tarr, & Selman, 2006; Zivin, 2012b). Individuals who have a mechanical prosthetic valve in the heart to counteract atrial fibrillation, those who are on dialysis for chronic renal failure, and individuals with *carotid stenosis* (narrowing of the carotid artery due to atherosclerosis) are at higher risk for ischemic stroke (Wirkowski, 2007).

CLASSIFICATION OF STROKE

Strokes are classified as follows:

- Ischemic stroke (occlusion of a blood vessel that diminishes blood flow to brain tissue)
- Hemorrhagic stroke (rupture of a blood vessel in the brain)

Ischemic Stroke

Most strokes are *ischemic strokes,* in which occlusion of a blood vessel reduces or eliminates blood flow to an area of the brain (van der Worp & van Gijn, 2007). If reduction in blood flow is severe, **infarction** (death) of brain tissue in the area supplied by that vessel occurs.

A common cause of ischemic stroke is a blood clot (**thrombus**) formed inside an artery that supplies brain tissue with blood. This condition, called *cerebral thrombosis,* blocks blood flow to an area of the brain, preventing brain tissue from obtaining needed oxygen. In the absence of oxygen, the brain tissue experiences infarction within a short period of time. The amount and severity of damage depend on the degree and duration of decreased blood flow.

Another cause of ischemic stroke is **embolism**, in which a clot that has formed in another part of the body breaks free and travels through the blood vessels to the brain, lodging in one of the cerebral arteries. In some instances, an *embolus* may be a substance, such as globule of fat, bubble of air, or foreign substance, that has entered the bloodstream and consequently occludes a vessel.

At times, temporary blocking of the cerebral arteries causes slight, temporary neurological deficits that lead to "mini-strokes," referred to as **transient ischemic attacks (TIAs)**. An important distinction between TIA and stroke is that the **ischemia** (deficiency of blood supply) associated with TIA is not severe enough to cause an infarction, whereas death to brain tissue occurs with stroke, causing permanent damage. Although the neurological deficits experienced from TIAs are usually temporary, their occurrence forewarns of the possibility of a larger stroke unless the underlying condition that precipitated the TIA is adequately managed.

Hemorrhagic Stroke

Hemorrhagic stroke occurs because of rupture of a blood vessel, causing *intracranial hemorrhage* (hemorrhage into the brain tissue). In this instance, death of brain tissue occurs not only because a certain area of the brain has been deprived of oxygen, but also because the escaped blood causes increased pressure in the brain (*increased intracranial pressure*) that compresses brain tissue against the skull, causing further damage.

A common cause of cerebral hemorrhage is uncontrolled **hypertension** (high blood pressure) (Zivin, 2012a). Other causes of hemorrhagic stroke include **aneurysm**, in which a thin-walled outpouching protrudes from a blood vessel. Aneurysms may be due to either weakness of the wall of the vessel or a congenital aberration. In many instances, aneurysms cause no manifestation until they burst (Brisman, Song, & Newell, 2006). Aneurysms may rupture directly in the brain (*intracerebral hemorrhage*), often into the **subarachnoid space** (the space that is filled with cerebrospinal fluid). As blood fills the subarachnoid space, *acute hydrocephalus* (sudden buildup of fluid in the brain) may occur, impeding the normal flow and absorption of cerebral spinal fluid (Ellegala & Day, 2005), which in turn causes increased *intracranial pressure* and subsequently more damage.

Another potential cause of hemorrhagic stroke is *arteriovenous malformation* (*AVM*), a congenital aberration characterized by a tangled web of arteries and veins connected by an abnormal passageway. AVMs may also cause hemorrhage into the subarachnoid space. These conditions also often go undetected unless they cause cerebral hemorrhage, although in some instances severe headaches or seizures may be the first manifestation (Friedlander, 2007; van Beijnum, Lovelock, Cordonnier, Rothwell, Klijn, &Al-Shahi Rustam Salman, 2009).

Cocaine or alcohol abuse can also contribute to the potential for hemorrhagic stroke.

MANIFESTATIONS OF STROKE

Whether a stroke is ischemic or hemorrhagic, the amount, degree, and type of function affected by stroke depend on three factors:

- The side of the brain affected
- The specific area of the brain that has been damaged
- The amount of damage that has occurred

After a stroke produces the initial damage to an area of the brain, surrounding brain tissue becomes **edematous** (swells) and inflamed, which leads to additional damage (Brown & Morgenstern, 2005). Although death of brain tissue causes permanent damage, areas of the brain that have experienced only swelling may recover, and function in these areas may be restored. Consequently, individuals experiencing stroke may not know the extent of their permanent functional limitations until weeks or even months after the initial event.

After stroke, a variety of *motor, sensory, cognitive, and communication* functions may be affected (Sandin, 2007), either singularly or in combination. In addition to the area of the brain damaged and the amount of damage that has occurred, the nature of functional manifestations experienced with stroke will, for the most part, be affected by whether the brain has been damaged on the left or right side. Individuals who experience stroke on the left side of the brain will have manifestations that affect the right side of the body and that are consistent with functions controlled by the left side of the brain. Likewise, individuals who experience stroke on the right side of the brain will have manifestations that affect the left side of the body and functions controlled by the right side of the brain.

Not all individuals with stroke have the same functional manifestations. The type and amount of function that are affected depend on the location and extent of the brain damage. Individuals may experience any or a combination of the general functional difficulties discussed next as a result of stroke.

Motor Manifestations

Individuals may experience weakness or paralysis on the side of the body opposite of the area of the brain that has been damaged by stroke. Consequently, voluntary control of power and strength in the extremities on the affected side of the body may be diminished. Either or both upper or lower extremities on one side of the body may be affected. If an upper extremity is involved, fine hand motions that are needed for writing, buttoning clothes, using eating utensils, or grooming may be affected. If a lower limb is affected, ability for walking or weight bearing may be affected.

Individuals may experience inability to manage the accuracy of muscle movement or limb position (**ataxia**). If an upper extremity is affected, they may have difficulty grasping or handling items. When a lower extremity is affected, they may walk with a wobbly, unsteady, staggering gait. As a result, there may be increased susceptibility to falls (Weerdesteyn, de Niet, van Dujn-hoven, & Geurts, 2008). In some individuals, equilibrium may be affected, making it difficult to maintain balance with resulting postural instability.

Coordination of movement that is unrelated to weakness or paralysis may also be affected. **Apraxia** is a term used to describe a manifestation in which individuals loses the ability to carry out purposeful, coordinated voluntary motor skills movements, despite having the physical ability to do so. The loss of the ability to conduct motor planning and to execute these voluntary movements efficiently is not related to weakness or paralysis, but rather to damage to the area of the brain that is responsible for voluntary coordinated movement. When a lower extremity is involved, ambulation may be difficult. When an upper extremity is involved, individuals may have difficulty controlling the accuracy needed for activities, so that grasping or reaching for objects is difficult. Apraxia can interfere with the ability to carry out activities of daily living and can impede independent functioning.

Sensation Manifestations

In some instances, individuals have sensation on one side of the body affected as a result of stroke. All sensations, or only one or two, including touch, pain, and sense of position, may be affected. Sensations may be totally lost, lessened, or sometimes misinterpreted. Alteration of sensory function or sensory loss may result in an unawareness of potential dangers to the affected side of the body, such as being too close to a hot stove.

Although loss of feeling or the inability to perceive movement of an extremity is most common in stoke, in some instances rather than feeling numbness, individuals may experience uncomfortable sensations such as tingling, burning, or pain (**paresthesia**).

When the portion of the brain responsible for perceiving visual images is damaged, the ability to perceive objects on one side of the visual field may be diminished. Consequently, individuals may be unable to perceive half of the visual field (**hemianopsia**). As a result, individuals may be able to perceive only half of a visual image. For instance, they may see food on only one half of the table.

Some individuals lose the ability to judge depth and distance, which can affect their ability to navigate within their environment. For example, individuals may stumble over or bump into furniture, run into the side of the door when trying to pass through it, or miss the edge of a table when trying to put down a glass.

The ability to recognize auditory or other sensations may be affected as well. Some individuals may be unable to recognize or identify certain objects, even though they recognize that the object is present and are able to describe its physical properties. Although they know they object is there, they may be unable to assign any meaning to it or its use. For example, they may see a cup placed in front of them and describe the cup's appearance, but not recognize how the cup is to be used or for which purpose.

Cognitive Manifestations

Cognitive function includes many domains, including memory, language, visual–spatial processes, and executive function, which incorporates decision making, judgment, planning, sequencing, and organizing. A wide variety of cognitive manifestations affecting any of these functions may be present after stroke.

Some individuals experience problems with memory. The degree to which memory is affected may be related to the side of the brain that was damaged. In some instances, individuals may have difficulty learning new material or retaining information that is newly learned. In other instances, individuals may have difficulty retaining more complicated information or may have a short retention span. There may also be difficulty with generalizing from one setting to another, and with perception of time.

After stroke, individuals may have difficulty reading (**alexia**) or writing (**agraphia**) due to cognitive difficulties rather than motor difficulties. In other instances, individuals may have difficulty recognizing once-familiar images or objects (**agnosia**).

Communication Manifestations

Communication is a multifaceted process that involves both receiving and delivering information, whether through behavior, speaking, writing, reading, or signing. Any difficulty with motor, visual, or cognitive function can affect an individual's ability to communicate.

Speech refers to the physical ability to produce sounds and/or movement of the lips, tongue, or other structures that are used to produce language. **Language** refers to how words, as symbols, are put together to convey and understand concepts. Both the ability to use certain muscles to form words and project speech and the ability to use and understand words (language) are controlled by the brain. When the area of the brain that controls either speech or language is damaged, limitations in either area may occur.

Motor difficulty in structures related to speech may affect the individual's ability to speak. Coordination and accuracy of movement of the muscles, lips, tongue, or other parts of the speech mechanism may be impaired secondary to weakness or paralysis of muscles needed to speak, a condition called **dysarthria**. Impairments may

range from speech that is slightly slurred to speech that is unintelligible. Paralysis or weakness of muscles may also cause vocal cord dysfunction, which in turn can affect voice quality.

Other motor problems can cause **articulation disorders** in which there is no significant weakness or incoordination for reflexive action, but rather the inability to position and sequence muscle movements properly. For example, individuals may be able to scrape a food particle off their teeth with their tongue, yet be unable to coordinate the muscles that move the tongue so as to produce a phonetic sound, a condition known as **apraxia of speech**.

Approximately 20% of individuals have difficulty with expression and comprehension of language after stroke (Dobkin, 2005). The ability to transmit /or understand verbal or written language (**aphasia**) may be hampered. Although a number of types of aphasia exist, two categories are commonly distinguished:

- Nonfluent (*expressive or motor*) aphasia
- Fluent (*receptive or sensory*) aphasia

Broca's aphasia is a type of *nonfluent aphasia* characterized by articulation problems, hesitancy, and reduced vocabulary and grammar. When *Broca's area* of the brain is damaged, an individual's speech may be labored, slow, or difficult to understand, and small connecting words, such as prepositions, may be omitted. Individuals may be able to understand and read simple material; however, as the complexity or length of the message increases, difficulty in completing these tasks becomes more apparent. Although individuals are able to comprehend material, they may have difficulty expressing their thoughts in speech and writing because of difficulty putting words and sentences together logically, or they may have word-finding difficulties (**dysnomia**). Reading ability may be better than writing ability.

Wernicke's aphasia is present when Wernicke's area of the brain is damaged. Wernicke's aphasia is a type of *fluent aphasia* in which there is effortless speech, relatively normal grammatical structure, and increased verbal output, but with reduced information content, so that what the individual says makes little sense. Auditory and reading comprehension is usually poor. Individuals with Wernicke's aphasia are typically unaware of their communication difficulties.

In some instances, individuals may experience **global aphasia**, in which there is severe difficulty communicating because of both inability to use language (inability to use words and organize them into coherent sentences) and severe difficulty in understanding language, either written or spoken.

Language difficulties may differ depending on the area of the brain damaged. Because the center of language function is located in the left cerebral hemisphere for most individuals, communication problems can occur when damage involves the left side of the brain. By contrast, individuals with right cerebral damage often have intact language function.

Brain damage can affect all forms of communication, including the ability to speak, comprehend, or convey language through either written or verbal means. The type of communication difficulty and the degree of communication difficulty individuals experience after stroke are greatly dependent on the side of the brain that incurred the damage.

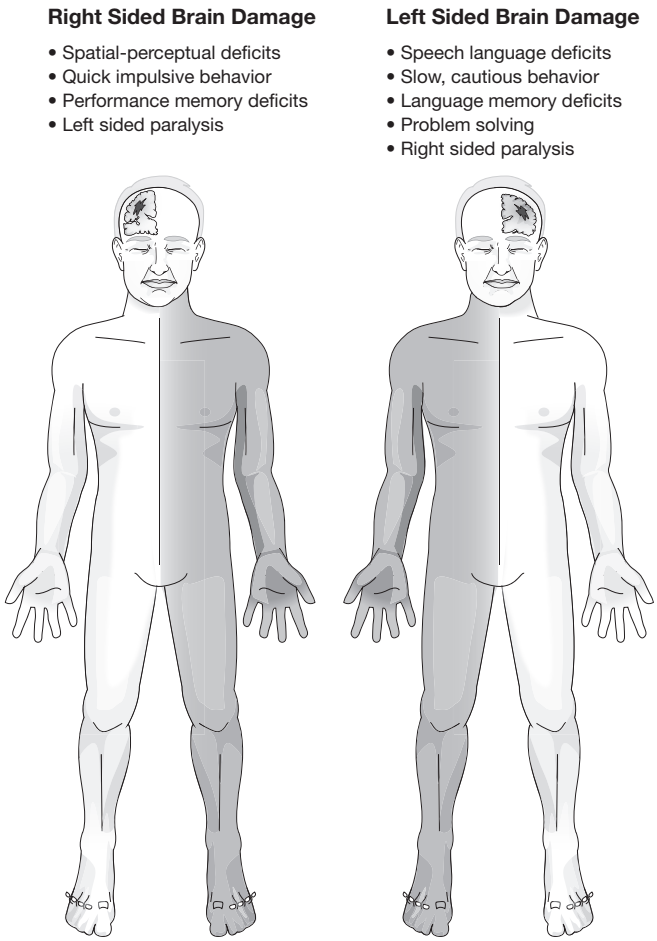
MANIFESTATIONS OF LEFT- VERSUS RIGHT-SIDED BRAIN DAMAGE

Although general functional manifestations as outlined previously may be experienced by many people with stroke, certain patterns of functional manifestations appear to be related to whether the damage occurred on the located on the left or right side of the brain, although exceptions can occur (**Figure 5-1**). Because the center of language function is located in the left cerebral hemisphere for most individuals, communication deficits can occur when damage involves the left side of the brain. By contrast, individuals with right cerebral damage often have intact language function.

Left-Sided Brain Damage

The most visible sign of left-sided brain damage, regardless of the underlying cause, is *right-sided motor and sensory paralysis* (right-sided **hemiplegia**). The degree of paralysis depends on the

Figure 5-1 Left vs Right Sided Brain Damage



extent of the damage. Either or both extremities on the right side may be affected to varying degrees, ranging from total paralysis to limited ability to use a limb. For individuals who are right-handed, everyday tasks such as feeding oneself, dressing, or a number of other motor activities may be significantly affected

Most people, regardless of whether they are left-handed or right-handed, have the language center located in the left hemisphere of the brain. The language center, which processes language symbols, affects auditory comprehension, speaking, reading, and writing. Consequently, left-sided stroke may interfere with the individual's ability to comprehend and use language (aphasia). The ability to communicate through speech, writing, or signs in left-sided brain damage are compromised because of damage to the language processing center of the brain, rather than because of impairment of the musculature involved in producing speech.

Although individuals with left-sided brain damage may be able to understand more than they can speak or write, they may have problems with both understanding and speaking. Some people have trouble pronouncing words because of the inability to coordinate muscles used in speech (**dysarthria**), causing their words to be slurred, slow, or difficult to understand, yet their language skills are intact.

Even though individuals may have difficulty with speech and language, their ability to learn

and communicate should neither be underestimated nor overestimated. Usually individuals with this type of communication difficulty will be able to understand short, concise statements better than long, complicated sentences. Individuals' ability to understand should not be underestimated even when they are unable to speak. Likewise, in those individuals who are able to speak, their ability to understand should not be overestimated.

Besides difficulty with language, individuals with left-sided brain damage tend to be slow, hesitant, anxious, and disorganized, especially when they are presented with new or unfamiliar situations. Reassurance and frequent reinforcement for tasks performed correctly help reduce anxiety and enhance these individuals' ability to perform.

Right-Sided Brain Damage

The most visible sign of right-sided brain damage is *left-sided motor and sensory paralysis.* Often right-sided brain damage is accompanied by some degree of visual perception loss or loss of visual motor integration that affects spatial/perceptual function. Functional consequences of spatial/perceptual difficulty can be manifested in several ways. Individuals may experience loss of depth perception or lack of awareness of stimuli on the left side of the body, causing difficulty with navigation within the environment. For instance, individuals may miss the table with a glass when putting it down or bump into a doorway when attempting to go through it. Individuals with right-sided brain damage may also have difficulty processing visual cues. Consequently, an uncluttered, simple, and structured environment can help to prevent distraction and may enhance the individual's ability to perform certain tasks. Spatial/perceptual manifestations of right-sided brain damage may also affect the individual's ability to read. For instance, the person may have an inability to move down the page without skipping lines.

Problems with memory may also be present with right-sided brain damage such that individuals are unable to recognize familiar people or places. In other instances, memory consequence is manifested as disorientation in familiar environments, so that individuals may require specific instructions about how to get from place to place. In other instances, memory difficulty may result in individuals forgetting where they have placed personal items and then concluding that someone else must have taken the items.

Because language function is often not affected with right-sided brain damage, the abilities of individuals with right-sided brain damage may be overestimated by others as well as by the individuals themselves. Individuals may be disinhibited and unaware of limitations they may have and consequently overestimate their own abilities to perform tasks, acting quickly and impulsively. As a result of diminished self-awareness, they may tend to set unrealistic goals and appear insensitive to the needs of others. In other instances, individuals may have difficulty decoding nonverbal cues from others and, as a result, be oblivious to others' reactions or feelings.

COMPLICATIONS AND OTHER ISSUES ASSOCIATED WITH STROKE

Spasticity/Contractures

When an extremity is paralyzed after stroke, it is initially flaccid; however, due to damage to the part of the brain that moderates muscle function, reflexes to the extremity become overactive, causing spasticity—a condition in which muscles contract and become rigid. Spasticity can cause pain and interfere with positioning of the extremity as well as function. A variety of physical modalities, such as stretching, cooling, or heating of the extremity, as well as medications may be used to manage spasticity.

Owing to flaccidity of an extremity and tightening of supporting tissue around joints of the extremity, a condition known as **contracture**, in which a joint becomes immobilized in a position of nonfunction, may occur. Appropriate positioning of extremities, range-of-motion exercises, stretching, and splinting are all interventions that may be utilized to prevent contractures from occurring (Lannin, Cusice, McCluskey, & Herbert, 2007; Turton & Britton, 2005).

Post-Stroke Seizures

Some individuals experience post-stroke seizures as a direct result of injury to the brain. Seizures

may occur immediately after stroke or may not occur until months afterward (Silverman, Restrepo, & Mathews, 2002). Management of post-stroke seizures is individualized and dependent on the functional impact of the seizures as well as on individual preferences (Ryvlin, Montavont, & Nighoghossian, 2006).

Pain

Individuals may experience pain after stroke as a direct result of brain injury. This condition, called *central pain syndrome*, causes the individual to experience diffuse and intense burning, tingling, or aching pain. Individuals are encouraged to avoid situations that may trigger the pain, or may be educated in relaxation techniques that may prove helpful.

A second type of pain experienced may be shoulder pain directly related to paralysis of an upper extremity, such that there is stretching or spasticity of the muscles supporting and around the shoulder joint. Support for the arm through use of a sling as well as other therapeutic exercises to decrease pain and increase function may be utilized (Reddy, Chae, Lew, Lombard, Edgley, & Moroz, 2009).

Dysphasia

Some individuals experience difficulty with swallowing (**dysphasia**) after stroke. This condition not only has implications for nutrition, but also can lead to pneumonia if individuals aspirate some of the food they are attempting to swallow. Interventions such as modifying a diet to include foods that are more easily swallowed may be utilized to work around dysphasia. In some instances, individuals may work with a swallowing therapist to help restore swallowing function (Eisenberg, & Rashbaum, 2011). In other instances, they may have a feeding tube inserted into their stomach to maintain nutrition and avoid food aspiration (Reddy et al., 2009).

Bowel and Bladder Control

As a result of stroke, some individuals lose the ability to control bowel and/or bladder function, which can be a source of frustration and social embarrassment. Bowel and or bladder difficulties may be a direct result of damage to neural pathways that control voluntary function. In other instances, it may be the result of difficulty getting to the toilet in time, or inability to adequately adjust clothing for toilet use. Sometimes bowel or bladder problems may be attributed to cognitive causes in which the individual does not recognize the need to evacuate bladder or bowel, or does not remember how to find bathroom facilities. Interventions for managing bladder and bowel problems depend on the cause, but may include regulation of fluid intake, establishing regular scheduled toileting patterns, establishing an effective bowel regime, or utilizing strategies or assistive devices that facilitate toilet use (Thomas et al., 2011).

Emotional Liability

After stroke, some individuals may exhibit a partial loss of emotional control, a condition known as *emotional liability.* Rather than being due to depression or sadness, this condition is a direct result of brain damage. With emotional liability, individuals may engage in prolonged crying or switch from laughing to crying, or from crying to laughing, when there is no apparent relationship between the emotional outburst and what is going on around them. The emotional reaction can often be diverted if the individual's attention can be directed to another activity. The individual's family may need support and guidance in dealing with the individual's outbursts.

Depression

Depression is common after stroke (Chemerinski, Robinson, & Kosier, 2001). Although adaptation to loss of various functions after stroke may involve a period of mourning, ongoing and prolonged depression may become a complication that impedes individuals' functional capacity and participation in the rehabilitation process. In addition, manifestations of depression may be misinterpreted as resulting in cognitive difficulties, so that adequate interventions for management of depression are not appropriately instituted.

Underlying Conditions Associated with Stroke

Individuals who have experienced one stroke are at higher risk for a subsequent second stroke (Hankey & Warlow, 1999). Often stroke is precipitated by an underlying chronic condition such as hypertension, arteriosclerosis, or diabetes. Consequently, ongoing management of underlying conditions is also important to prevent further strokes from occurring and to optimize the individuals' rehabilitation process. Due to physical, cognitive, or emotional manifestations of stroke, however, management of underlying conditions may be more difficult.

MANAGEMENT OF STROKE

Comprehensive rehabilitation and other therapeutic programs are often required for months to years after stroke to help individuals recover ability and adapt to the residual effects of stroke. The overall goal of rehabilitation after stroke is to help the individual reestablish, and optimize, his or her independence, and to return to preexisting roles and relationships to the extent possible (Koch, Egbert, Coeling, & Ayers, 2005). Recovery and adaptation after stroke comprise a multifaceted process that requires attention to the physical, cognitive, and psychosocial aspects of function. A comprehensive approach to rehabilitation entails a multidisciplinary team approach involving a number of professionals, including physiatrists, rehabilitation nurses, physical therapists, occupational therapists, speech therapists, nutritionists, psychologists, social workers, and rehabilitation counselors. Individuals experiencing stroke, along with their family and friends, need support, education, and training to optimize rehabilitation efforts. In addition, the individual's physical environment should be evaluated and modified to compensate for manifestations of stroke that may impede optimal functional capacity.

After stabilization in the early phases of stroke, the major focus of management is restoration of function, reduction of limitations, and prevention of complications. Most natural motor and functional recovery occurs in the first three months after stroke (Bjorkdahl, Nilsson, Grimby, & Sunnerhagen, 2006; Dobkin, 2005), although additional progress can be made through continuing rehabilitation. *Physical therapy* and *occupational therapy* are usually instituted early in the early stages of rehabilitation and continue to be provided during the post-acute phase. In the early stages of rehabilitation, the focus is on helping individuals increase strength and prevent deformities, such as *contractures*, that might interfere with functional capacity.

Many individuals have some limitations in walking after stroke, which places them at risk for falls and subsequent fractures. Consequently, improving functional walking capacity is a major goal of physical rehabilitation (Duncan et al., 2011). As rehabilitation progresses, goals such as achieving independent walking, helping individuals use assistive devices such as a cane or walker, and performing transfers such as from bed to chair become primary goals.

When the hand and arm are also affected, management is directed toward helping individuals achieve self-care tasks such as feeding, bathing, and toileting and in educating them in the use of assistive devices for carrying out tasks of daily living. *Speech therapy* is instituted for those individuals who experience *aphasia*. Because the types and severity of aphasia vary widely, management is based on individual needs.

After the acute phase of stroke rehabilitation, individuals may move to an extended residential care facility for continued rehabilitation, or they may return home and continue rehabilitation on an outpatient basis.

The degree to which individuals are able to achieve optimal function varies and depends on a number of factors, including the location and extent of stroke as well as any preexisting conditions. Other factors of importance are the individual's psychological state, degree of social support, and general environment. For this reason, attention must also be given to the individual's family and social network as well as the physical and social environment in which they function.

FUNCTIONAL IMPLICATIONS OF STROKE

Personal and Psychosocial Issues

The effects of stroke are far-reaching. Not only is stroke associated with many physical and neurobehavioral manifestations, but cognitive, emotional, and social role functioning is affected as well. Changes associated with stroke have many long-term psychological and social implications (Jones, 2006). Adjustment to any change of function due to a chronic condition can be difficult, of course, but manifestations of stroke can offer particular challenges. Stroke can result in loss of functional independence, thereby altering an individual's perception of competency, identity, self-concept, and self-esteem (Vickery, 2006). In some instances, the individual may not accurately perceive the functional implications of the stroke, which may interfere with effective rehabilitation efforts (Powell, Johnston, & Johnston, 2007).

The psychosocial, physical, and economic consequences of stroke can pose a major challenge to the family as well as to the individual (Palmer, Glass, Palmer, Loo, & Wegener, 2004; Sandin, 2007). Stroke can create a psychosocial crisis for the family not only because of the functional manifestations the individual experienced due to stroke, but also because of the resulting increased caregiving responsibilities that family members must assume, often with little training or support (Palmer & Glass, 2003). Although in the past much of this rehabilitation effort took place in the hospital before discharge, individuals who experience stroke may now be discharged much earlier, with much of the rehabilitation that had previously taken place in the hospital being conducted on an outpatient basis. Families may be unprepared for the complexity of interventions needed, the economic consequences, and their own role in contributing to effective rehabilitation outcomes for the individual after stroke (Palmer et al.).

Stroke rehabilitation must focus not only on recovery of muscle strength, range of motion, or mobility, but also on rebuilding of individuals' identity, roles, and relationships (Palmer & Glass, 2003). Depending on the extent of brain damage experienced with stroke, individuals may require extensive and ongoing rehabilitation.

Activities and Participation

Physical, cognitive, and emotional residual manifestations of stroke can affect self-care or activities of daily living and community integration. Ongoing rehabilitation efforts involve optimizing functional capacity and societal roles as desired. Continued follow-up with a multidisciplinary team of professionals is necessary to work toward continued optimal capacity, monitor progress, identify barriers, and assess continued needs.

Activities of Daily Living

Because self-care and activities of daily living are often altered by stroke, the individual may need to learn alternative methods of performing routine tasks. Fatigue is often a secondary manifestation after stroke. Thus individuals may need to space out activities or arrange for frequent rest periods during the day. Activities that could once be completed in a short amount of time may need to be divided into a series of smaller tasks carried out over time.

Family Participation

Even when alternative methods are utilized, help from family members or others may be necessary. Family members can become overwhelmed by the responsibility but be reluctant to express their own feelings of frustration or helplessness. Unless families are helped to cope with their frustration and learn strategies to help them cope with the situation, increased stress can disrupt family function and interfere with the individual's progress. In some instances, families may become overly protective, so that the individual with stroke is hampered from reaching optimal function and independence. Wanting to shield the individual from what is perceived as stressful, family members may exclude the individual from family problems or decision making or limit his or her inclusion in family activities. At times it may be difficult to determine the degree to which the individual's ability or inability to function is due to the stroke itself or the degree

to which ability or inability is induced by the situation. It is important for family members to reassure the individual that he or she continues to be a valued and needed member of the family unit and helpful for the family to have the individual participate in as many family and other activities as possible.

Families can help by demonstrating confidence, encouraging the individual, and enabling the family member to do as much for himself or herself as possible. Although the family can be the most effective resource for assisting the individual to reach his or her goals, help and support from other professionals can help to reduce stress and provide assistance to the family in areas where needed. Continued guidance and support from professionals can assist families resolve difficulties they may be experiencing in adjusting to role changes and responsibilities that are the result of manifestations of stroke.

Social Participation

Manifestations of stroke can alter social performance and precipitate significant role changes. Members of the larger social environment may lack a thorough understanding of stroke and its implications for physical, and emotional function, or they may misinterpret manifestations of stroke, such as emotional liability and problems with memory, attention, or judgment. Rather than attributing behaviors to results of stroke, post-stroke individuals may be perceived to be rude, insensitive, or irresponsible. In other instances, the people in the broader social community may feel uncomfortable due to their own perceived inadequacy in knowing how to respond to individuals with stroke, consequently avoiding interactions altogether.

Rebuffs from people in the social environment can cause the individual with stroke to experience social anxiety and produce low self-esteem. Individuals with stroke may experience frustration and less self-assurance in the struggle to cope with social demands. Promoting greater awareness in the community can help create more openness and acceptance. Nevertheless, after stroke, an individual may need to learn and adopt compensatory mechanisms or strategies to be implemented in a variety of social interactions.

Sexuality

Sexuality involves much more than just sexual intercourse. Regardless of their ability or desire to engage in sexual activity per se, after stroke individuals continue to need warm, close personal relationships and to feel attractive to others. There are many different ways to fulfill a need for closeness; sexual intercourse is only one way. If individuals were sexually active prior to the stroke, resuming sexual activity would be a natural part of general activity.

Patience and loving communication are essential to a satisfying relationship. If the individual has a partner, there may be unspoken fears that both are frightened to discuss, which can in turn lead to isolation and stress in the overall relationship. Individuals who have experienced stroke may fear that they will be rejected by or are unattractive to their partner. The partner may fear that engaging in sexual activity will precipitate another stroke. Obtaining assistance from professionals who can help both partners discuss their fears can help to strengthen the relationship.

Environmental Modifications and Assistive Devices

Making home modifications or identifying accessible areas in the community environment help the individual with stroke to achieve increased independence. In addition, a number of assistive devices are available for increased function. Assistive devices need not be costly, and sometimes the most effective device can be devised from simple materials already available in the home.

VOCATIONAL IMPLICATIONS OF STROKE

The number of individuals who return to work after stroke ranges from 19% to 73% (Treger, Shames, Giaquinto, & Ring, 2007). The extent to which an individual is able to return to work is multifactorial. Age, education, social support,

and severity of stroke all contribute to vocational potential. In addition, the type of job, its physical demands and complexity, interpersonal and language requirements, and visual perceptual requirements of the job must be considered. Although there is the common misperception that stroke affects mostly older individuals and, therefore, has less vocational impact, many people at the time of stroke are still active in the workforce. Approximately one-fourth of individuals who experience stroke are younger than the age of 65 (Centers for Disease Control and Prevention, 2011).

Vocational implications for individuals with stroke vary widely, depending on the specific and individual manifestations exhibited. Specific functions that should be considered are cognitive function, such as memory, problem-solving ability, and spatial and temporal orientation , as well as motor abilities, including coordination, balance, speed of performance, and muscle dexterity.

If communication skills are affected, alternative means of communicating in the workplace or computer-assisted communication may be needed. In many instances, even though individuals' communication may be difficult to understand, patience and practice will enable coworkers to establish basic patterns of communication that make interchange in the workplace possible.

When manifestations of stroke include difficulty with motor skills such as ambulation, manual dexterity, or coordination, demands of the job that include walking, lifting, pulling, or pushing should be evaluated, and workplace modification or specific devices to assist in motor tasks may be needed.

If individuals experience poor motor speed or decreased processing ability as a manifestation of stroke, they may feel rushed or stressed when trying to perform tasks. An environment that has minimal distractions and is free from clutter can be beneficial in such cases. If individuals feel pressure to perform, they may experience stress, and consequently the quality of their work may be affected. Individuals may experience fatigue as a direct consequence of brain damage, or job stress may lead to fatigue. Dividing tasks into smaller steps and taking advantage of frequent rest periods can help to decrease fatigue. Providing an environment in which the individual experiences less pressure and stress can help increase both productivity and quality of work.

Another factor that may either enhance or diminish individuals' ability to reach their full vocational potential may be transportation. Often the individual's ability to drive is affected by stroke owing to motor manifestations such as paralysis, visual spatial manifestations, or cognitive manifestations that include judgment. If the individual is no longer able to drive, finding an alternative way to reach the place of employment is important to facilitate return to work.

Realistic expectations about level of performance are an important component of success. If the individual, his or her family, or the workplace have not adequately and realistically evaluated the employee's capacity to perform, or if they have not provided the modifications or assistive devices that would enable the individual to carry out job tasks, the probability of failure increases. In such circumstances, individuals may become so discouraged that they lose the motivation to try. Ongoing evaluation of progress in the workplace, provision of resources to meet needs as they arise, and continued support all contribute to vocational success.

CASE STUDY

Ms. L., a 49-year-old accountant, had complained of headaches for several days before collapsing in her office. She was immediately taken to the emergency room by ambulance and was found to have experienced a stroke due to cerebral aneurysm on the left side of her brain.

1. Which residual manifestations might Ms. L. experience as a result of left-sided brain damage?
2. How might the manifestations affect her ability to continue her work as an accountant?
3. Depending on the extent and type of residual manifestations, which types of work modification or assistive devices may be beneficial to Ms. L. in continuing her current line of work?

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