

Exercise Programs for Stroke Survivors

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Each year, people suffer 795,000 strokes (Roger, Go et al. 2011), otherwise known as cerebrovascular accidents (CVA). There are generally 2 types of stroke: hemorrhagic or ischemic. 86% percent of strokes are ischemic, meaning blood flow to the brain is cut off, usually from a thrombus or embolism. The remaining are hemorrhagic, often resulting from a ruptured blood vessel in the brain which increases intracranial pressure and cell death.

A recent article from the American Heart Association (AHA) provides valuable statistics on strokes and heart disease (Roger, Go et al. 2011).

- New strokes account for 77% of all strokes, and over 50% of people over 45 years old die within 5 years after their first stroke.
- 137,000 people die from strokes each year, making it the 3rd leading cause of death: 1 out of 18 people die each year from stroke.
- Younger stroke survivors 55 to 64 years old live longer (males 13.1 years and females 7.8 years) than survivors over 75 years old (males 2.1 years and females 2.3 years).
- 50-70% of stroke survivors regain functional independence, while 15-30% remain permanently disabled.

The National Stroke Association estimates that 6 million people in the United States today have survived a stroke (National Stroke Association 2011). This number is expected to rise with improved awareness and treatment, as well as an increase in persons with risk factors for stroke such as diabetes and obesity. Lifestyle modification and pharmacologic therapies are often used to prevent another stroke.

Even after rehabilitation, stroke survivors are often left with disabilities that may benefit from a specialized exercise program: half of stroke survivors have hemiparesis, 30% require assistance with walking, and 26% have deficits in activities of daily living (ADL) (Roger, Go et al. 2011). Hemiparesis affects the contralateral side of the body from the stroke because the muscles are controlled from the opposite side of the brain: the left brain hemisphere controls the muscles on the right side of the body and vice-versa. Depending on the location and severity of the stroke, residual deficits can be quite varied and may include speech and memory impairments.

Community-based exercise programs can significantly improve physical performance in stroke survivors at reduced costs compared to conventional care (Harrington, Taylor et al. 2010). While it's unlikely that an exercise program after stroke rehabilitation will restore patients to pre-stroke functional levels, regular physical activity is recommended by the AHA in order to maintain functional levels (Gordon, Gulanick et al. 2004). According to the AHA (Gordon, Gulanick et al. 2004), 3 major goals of exercise in stroke patients are to 1) prevent complications of prolonged physical inactivity; 2) decrease recurrent stroke; and 3) increase aerobic fitness. In addition, physical activity may reduce risk factors of stroke.

Daily physical activity has been associated with better health-related quality of life (HRQL) in stroke survivors (Rand, Eng et al. 2010)

Although several exercise intervention studies in stroke patients have been published, the heterogeneity of subject populations (different ages, disabilities, and time after stroke) and the differences in interventions between studies make meta-analysis difficult. When interpreting the outcomes of exercise training studies on post-stroke patients, it's important to pay attention to the inclusion and exclusion criteria of the subjects, the specific interventions, and the outcomes measured.

Before beginning any exercise program after a stroke, the American College of Sports Medicine (ACSM) and AHA recommend medical clearance and exercise testing (Gordon, Gulanick et al. 2004; Palmer-McLean and Harbst 2009). Stroke survivors often have co-morbidities that may affect their ability to exercise. Quite often, these co-morbidities are the same risk factors that may have led to the stroke: hypertension, diabetes, obesity, coronary artery disease, smoking, obesity, and physical inactivity.

Saunders and colleagues (Saunders, Greig et al. 2009) completed a Cochrane review of fitness training in stroke patients. They reported that there is sufficient evidence to support cardiovascular training in stroke patients, but not enough evidence to support strength training. In a more recent meta-analysis of stroke patients with mild-to-moderate impairments, Harris et al. (Harris and Eng 2010) suggested that stroke patients performing strength training have quicker gains in grip strength and upper extremity function. Interestingly, however, they found no effect of strength training on ADL.

The most difficult aspect of exercise prescription in stroke survivors is working with neuromuscular deficits: muscle flaccidity (paralysis), spasticity (hypertonicity), and poor balance. These deficits lead to difficulties in ambulation, transfers, and ADL. Many years ago, it was thought that exercise (especially strength training) would increase spasticity without improving paralysis; however, recent research has shown that strength training can improve function in stroke survivors without increasing tone (Badics, Wittmann et al. 2002; Flansbjerg, Miller et al. 2008). This might be due to 'neural plasticity,' where the brain makes new connections, rather than re-generating brain cells that die after a stroke.

Physical activity recommendations after stroke are listed in Table 1. They include a well-rounded physical activity program of cardio, strength, flexibility, and balance activities for individuals with mild-to-moderate disability. Interestingly, these AHA recommendations (Gordon, Gulanick et al. 2004) are not different from current physical activity recommendations for healthy adults.

Cardiovascular Exercise	20-60 minutes, 3 to 7 days / week RPE 11-14, 50-80% Max HR
Strengthening Exercises	1 to 3 sets, 10-15 reps 8 to 10 exercises, 2-3 days / week
Flexibility Exercises	2-3 days / week; 10-30 second holds
Neuromuscular / Balance Exercises	2-3 days / week

Table 1: Guidelines for physical activity prescription after stroke (Gordon, Gulanick et al. 2004)

Cardiovascular Exercise. Most literature on post-stroke populations utilizes aerobic training on a stationary bicycle or treadmill walking. Stationary cycling can improve aerobic capacity (Potempa, Lopez

et al. 1995) and may be the best option for patients with lower extremity hemiplegia by allowing the involved foot to be secured to the pedal. Treadmill exercise with or without support can increase aerobic capacity and sensorimotor function (Hesse, Bertelt et al. 1995; Potempa, Lopez et al. 1995; Macko, Smith et al. 2001). Furthermore, combining treadmill walking with leg weights may improve functional ambulation (Lam, Luttmann et al. 2009). Treadmill ambulation with a support harness may be better for walking outcomes, but not strength (Sullivan, Brown et al. 2007). Recently, however, supported treadmill walking was found to be as effective as physical therapist-led home exercise programs on gait, balance, and quality of life (Duncan, Sullivan et al. 2011). Depending on individual fall risk and independence in ambulation, community-based walking or other group aerobic exercise programs can also be used for cardiovascular exercise.

Strengthening exercise. As stated previously, strength training in stroke survivors does not increase muscular tone; however, stroke patients less than 6 months post-stroke may not benefit from strength training (Moreland, Goldsmith et al. 2003). High-intensity strengthening (> 70% maximum) can safely increase strength, balance and mobility in post-stroke patients (Weiss, Suzuki et al. 2000). Resistance training can be performed with machines, elastic bands, or free weights. Machine-based resistance training can be safe, effective, and easy to use with stroke patients (Weiss, Suzuki et al. 2000; Badics, Wittmann et al. 2002; Flansbjerg, Miller et al. 2008; Lee, Kilbreath et al. 2010); however, machines can be expensive and bulky. Elastic bands and light dumbbells are better for community-based group exercise programs or home exercise programs. Table 3 provides a list of recommended strengthening exercises in post-stroke patients. Obviously, an exercise program can be tailored to individual weaknesses.

Upper Extremity	Lower Extremity
Elbow extension	Hip extension
Shoulder external rotation	Hip abduction
Wrist extension	Ankle dorsiflexion
Shoulder diagonal	Knee extension
Shoulder flexion	
Shoulder abduction	
Shoulder extension	

Table 3. Strengthening exercises for post-stroke patients.

Several studies have shown that community-based or home exercise programs with elastic bands can safely and effectively increase strength, balance, function, and gait in stroke survivors (Duncan, Studenski et al. 2003; Pang, Eng et al. 2005; Cramp, Greenwood et al. 2006; Pang, Harris et al. 2006; Duncan, Sullivan et al. 2007; English, Hillier et al. 2007; Cramp, Greenwood et al. 2010; Harrington, Taylor et al. 2010; Duncan, Sullivan et al. 2011). In addition, aquatic exercise may be beneficial to increase strength and balance in stroke patients (Noh, Lim et al. 2008). Adding task-specific activities and body-weight exercises such as walking over obstacles, step-ups, sit-to-stand, marching, and reaching for objects may compliment strengthening programs for stroke patients (Duncan, Studenski et al. 2003).

Balance training. Specific recommendations for balance training in stroke patients are not available due to a lack of studies; therefore, the AHA only recommends performing balance training 2 to 3 times per week. There is some evidence that balance training can improve balance and gait (Chen, Cheng et al.

2002; Goljar, Burger et al. 2010), but more research is needed. Sitting balance activities such as reaching for objects can be helpful (Duncan, Sullivan et al. 2007; Duncan, Sullivan et al. 2011). Standing balance exercises such as staggered-stance, single leg balance, and standing on unstable surfaces such as foam pads and wobble boards can provide additional challenges (Stock and Mork 2009). Catching or kicking small balls can also be used for training dynamic standing balance, and further challenged by standing on unstable surfaces.

Stretching exercises. Similar to balance training, there is a lack of evidence on specific stretching interventions in stroke survivors. Marigold et al. (Marigold, Eng et al. 2005) compared stretching to agility exercises in post-stroke patients; they found that both interventions improved physical performance, but the agility group had fewer falls and better balance reactions. Exercise interventions for stroke patients often include stretching muscles that are tight or have increased tone in the upper and lower extremities. It's important to perform stretching exercises slowly without bouncing to avoid increasing tone. While every stroke patient is different, commonly tight muscles include the pectoralis, biceps, wrist flexors, hamstrings, gastroc-soleus, hip adductors and hip flexors. Overhead shoulder pulleys may also be beneficial for stroke patients with reduced shoulder range of motion.

As with any chronic medical condition, consider medications and their effects on exercise. Remember that patients taking beta blockers or calcium channel blockers may experience lower than normal heart rates; therefore, use the rating of perceived exertion (RPE) scale for intensity. In addition, exercise professionals should be aware of signs and symptoms to terminate exercise in stroke patients. These are listed in Table 3.

Significant changes in heart rate or blood pressure Cyanosis Excessive sweating Bilateral limb edema Angina Pallor Shortness of breath Dizziness Severe headache Sudden onset of numbness or weakness
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Table 3. Signs and symptoms to terminate exercise

An important consideration with any exercise prescription is behavior modification. Damush et al. (Damush, Plue et al. 2007) noted 3 barriers and 3 facilitators to exercise in stroke survivors (Table 4). Exercise professionals should be aware of these issues and incorporate facilitators and strategies to avoid barriers in post-stroke physical activity programs.

Barriers	Facilitators
Physical impairment	Motivation
Lack of motivation	Social support
Enviromental factors	Planned activities to fill an empty schedule

Table 4: Barriers and facilitators to exercise in stroke survivors (Damush, Plue et al. 2007)

In conclusion, stroke survivors with mild-to-moderate impairments can benefit from an exercise program. A well-rounded program including cardio, strength, balance and flexibility exercise is recommended by the AHA and the ACSM. This article has provided exercise professionals with an evidence-led approach to exercise prescription in stroke survivors.

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