

Stroke Rehabilitation

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Abstract: *Rehabilitation of patients post-stroke seeks to facilitate functional recovery by means of therapeutic modalities which enhance motor learning and cortical reorganization in the plastic post-stroke neural environment. Therapeutic interventions initiated early post infarct, which are task specific and repetitive, improve recovery. Comprehensive stroke rehabilitation enhances functional independence, decreases mortality and increases the percentage of patients who are able to return to a home setting post discharge. In this review of stroke rehabilitation, the neurobiology of recovery from stroke, timing of rehabilitation, and the main facets of rehabilitation will be discussed.*

Introduction

Stroke is the leading cause of disability in the United States. Approximately 700,000 people experience a stroke each year. There are an estimated 5 million stroke survivors living in the United States. Stroke places a financial burden on our society with the projected cost of stroke care in 2007 approaching 62 billion dollars.¹

The most significant physical impact on stroke survivors is long term disability. In the stroke survivor population, 50% have some level of hemiparesis, 30% are unable to walk without some assistance and 20% are dependent in activities of daily living.¹ The result of this disability is a significant impact on independence, quality of life and lost productivity.

Acute Rehabilitation

The benefit of coordinated interdisciplinary stroke care has been shown to reduce mortality, reduce the percentage of patients requiring institutionalization and reduce dependency in mobility and self-care skills.² Post stroke rehabilitation may be provided in three primary venues which include: outpatient centers, acute inpatient hospitals/units and skilled nursing facilities. The primary determinant of which level of care is appropriate is based on the patient's functional level, their level of endurance, and the intensity of medical monitoring and management required. The most medically complex and physically challenging patients are often admitted to an acute inpatient rehabilitation unit. (*Figure 1, p. 27*)

The numerous medical co-morbidities commonly associated with stroke patients require significant medical management during their rehabilitation stay. In a review of stroke patients in an acute rehabilitation unit, 75% of patients experienced at least one medical complication requiring medical intervention.⁴ One of the primary roles of the rehabilitation physician in the inpatient setting is successful management of existing co-morbidities as well as reducing the occurrence of associated illnesses. Some associated illnesses which stroke patients

are prone to have are: urinary tract infection, deep venous thrombosis and aspiration pneumonia. Successful prevention and management of medical co-morbidities facilitate full participation of the patient in rehabilitation and helps them to achieve maximum benefit from the rehabilitative interventions.

Neurobiology of Rehabilitation

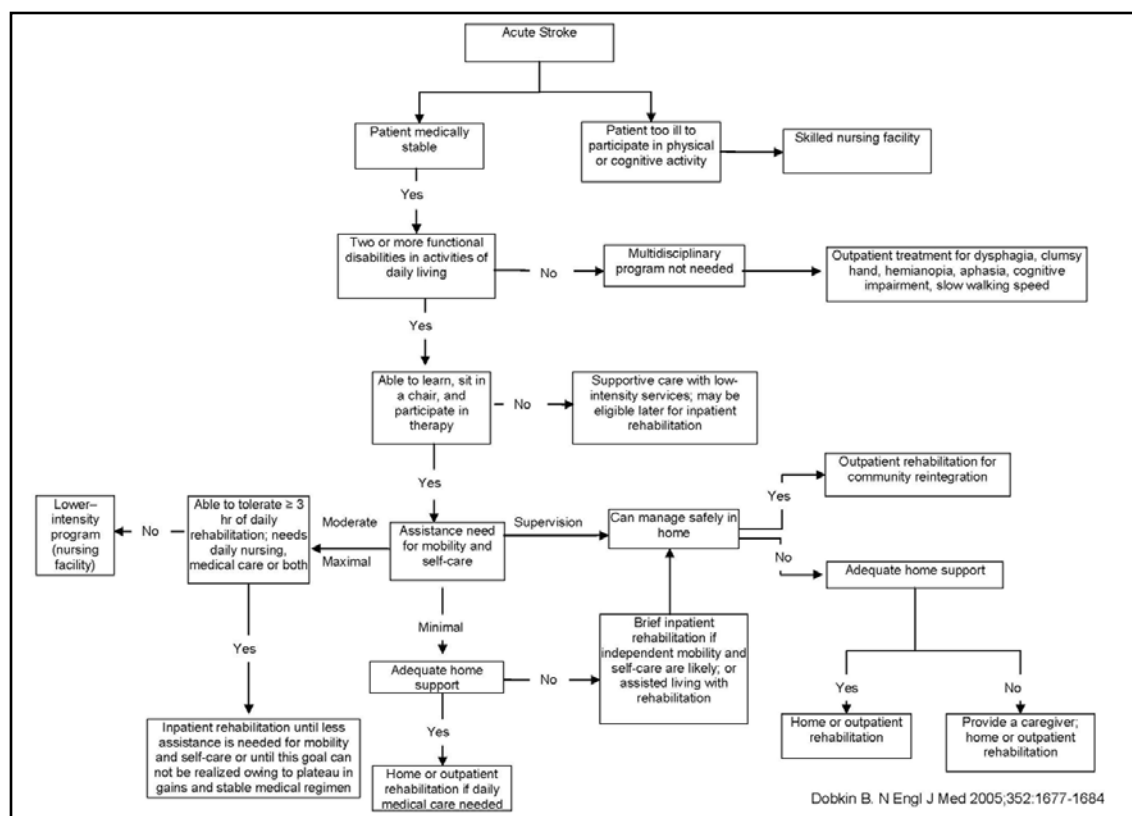
The developing comprehension of the neurobiology of brain infarction and the peri-infarct neural environment, and the advances in neuro-imaging techniques including regional cerebral blood flow measures, regional cerebral metabolism of glucose and oxygen, positron emission tomography (PET), Diffusion Weighted Imaging (DWI) and perfusion scans are helping to further identify structural and biochemical changes occurring in neural tissues after stroke.^{5,6,7,8} The increasing body of scientific understanding of the post cerebral infarct environment is providing a more solid foundation for the development of interventions that can specifically address the functional deficits of stroke patients, as well as the appropriate timing of these interventions.

It is becoming increasingly evident that the post-stroke brain is an environment primed for recovery and receptive to potential therapeutic modulation. The adult brain, pre and post injury, has been shown to be *plastic* in nature which signifies an ability to modify the structural neural-components as a result of a change in the environment.^{9,10} Brains of adult animals that were exposed to an enriched environment and underwent tasks involving motor learning resulted in histological changes in the cortex such as increased growth of dendrites, synaptogenesis, and astrocytic proliferation.¹¹ The post stroke neural environment has been shown to encourage axonal sprouting through growth promoting gene induction and a reduction in growth inhibitory neural chemicals.¹² Neuroblast migration to the area of injury has been demonstrated in animal models to be significantly influenced by chemicals such as erythropoietin.¹³ Angiogenesis in the peri-infarct tissue is also promoted by angiopoietin, as well as other neural chemicals.^{14,15}

Cortical re-organization has been demonstrated for some time in animal models following cortical injury and subsequent rehabilitation.¹⁶ Human stroke patients have also been shown to demonstrate an enlarging and/or shifting of their cortical map following injury and subsequent rehabilitation.¹⁷ This shift in cortical function results in activation of brain neurons that are outside primary control sites to subserve brain control over actions that are impaired by the stroke. For example, following ischemic injury to the primary motor cortex, the ipsilateral supplementary motor cortex and the contralateral frontal motor areas can activate limb muscles.

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Figure 1 Algorithm for Placement for Rehabilitation Care After Stroke³



Post stroke therapeutic interventions should be appropriately timed and directed toward the specific neural substrate to maximize cortical reorganization. It is recognized that the earlier the implementation of therapy, the better functional outcome.¹⁸ A 2005 American Stroke Association endorsed Clinical Practice Guideline¹⁹ recommends that rehabilitation therapy start as soon as possible. Rehabilitation immediately post stroke seeks to modulate three components of neural recovery and adaptation which include: 1) The “training” effect that all brains undergo as a result of an exercise regimen resulting in increased dendritic sprouting and increased efficiency of synaptic transmission; 2) The resolution of diaschisis which is a variable, but relatively short term phenomenon occurring acutely after a stroke, which results in the depression of local cerebral blood flow and metabolism extending beyond the actual area of infarct;²⁰ and 3) The facilitation of cortical reorganization through therapeutic interventions specifically directed toward the impaired neural substrate.

Focuses of Rehabilitation

There are four primary areas of focus for therapeutic rehabilitative intervention in stroke patients: mobility, self-care, language deficits and swallowing impairment. The rehabilitation physician also plays a role in detecting and treating spasticity and mood disorders following stroke.

Mobility

Therapy goals and treatment interventions are adjusted according to the severity of the patient’s lower extremity motor deficits. The primary focus for non-ambulatory patients is

training in bed mobility, sitting balance, and transfer skills to allow greater ease with management in the home setting with regard to bed-to-chair transfers and chair-to-toilet transfers. Patients with adequate trunk balance and lower extremity strength to stand and initiate swing are able to begin gait training. Gait training should be task specific and focus on the key components of gait with significant repetition to promote superior outcomes with regard to gait speed and distance.^{21,22} Body weight supported treadmill training (BWSTT) involves supporting a patient with a harness suspended from an overhead frame with up to 40 % of their weight off loaded and then placed over a treadmill for gait training.²³ The benefits of BWSTT include more symmetric weight shifting on the affected extremity, tolerance for faster speeds during gait training and a greater degree of repetition.²⁴ Although the present data are inconclusive and clinical trials are underway, it appears that BWSTT may be a promising treatment option for gait recovery.²⁴ Resistive exercises focused on lower extremity strengthening provide additional benefit with regard to gait recovery.^{25,26}

Self Care

Self care tasks, which include both basic Activities of Daily Living (ADLs: bathing, dressing, and grooming) and more complex ADLs (cooking and upper extremity retraining), are important areas that require therapeutic attention and intervention. ADL therapeutic goals are determined based on the severity of the motor deficit of the affected upper extremity. The initial focus of ADL training includes instruction in basic

tasks such as grooming, hygiene, toileting, and dressing skills. The therapist begins with compensatory training techniques and may introduce adaptive equipment such as a reacher or sock-aide to facilitate dressing independence. As the patient functionally progresses, more complex (instrumental) ADLs are addressed e.g. meal preparation, and lessons include both the cognitive and physical components of the task.

Upper extremity retraining is initiated based on the degree of motor deficit. For the flaccid extremity the primary focus is instruction in positioning and edema control measures, both with elevation of the distal extremity and use of a compressive glove. Splinting of the upper extremity has been a mainstay of treatment with the intent to maintain range of motion and to decrease pain as well as spasticity. A recent clinical trial, however, has cast doubt on the benefit of splinting for either maintenance of wrist range of motion or reduction in spasticity with the use of a forearm splint at night.²⁷

Several therapeutic modalities including neuromuscular electrical stimulation (NES), constraint induced movement therapy (CIMT) and interactive robotic therapy (IRT) are based on motor learning principles and have shown promise in promoting recovery of the upper extremity.

Neuromuscular electrical stimulation, either with or without an EMG trigger, is performed by applying surface electrodes to extensor muscles of the wrist and fingers and delivering a timed electrical pulse to facilitate wrist and or finger extension. This modality is enhanced when repeatedly performed with a grasp and release task specific activity. A benefit of improved wrist and finger extension has been shown in randomized controlled trials in both acute and chronic strokes using NES.^{28, 29}

Constraint induced movement therapy (CIMT) is an intense short duration training program which involves constraining the unaffected extremity with some type of mitt for 90% of the day (waking hours) and concurrent repetitive practice (shaping) activities with the affected extremity for six hours a day for two weeks. There are specific motor criteria that must be met for a patient to participate in this therapeutic modality, thus restricting availability to many patients. CIMT has been shown to be effective both with chronic³⁰ and acute³¹ stroke patients in improving strength and functional use of the affected upper extremity. It is uncertain if the benefits result from the massed practice (shaping) alone, or if the constraint of the unaffected extremity actually contributes to the improved function.

Interactive robotic therapy is another upper extremity therapeutic modality which incorporates motor learning principles and sensory integration techniques. A variety of devices have been used, but generally consist of a robotic joystick that can be programmed to provide passive, active assisted and resisted range of motion in planar modes to the affected upper extremity. The automated features of this modality allow the patient to perform multiple repetitions of a specific exercise regimen with only limited therapist intervention. Robotic therapy has been shown to be effective in improving strength and performance in functional activities.^{32,33}

Language Deficits

Approximately 19% of stroke patients exhibit language deficits in the area of expression and comprehension following a stroke. The primary focus of speech therapy is to first facilitate the aphasic patient's ability to communicate basic needs by means of a consistent yes/no response either verbally or with head motion. Communication boards (simple board with pictures to point to or letters to spell out words) may be utilized as an augmentative device to allow the patient to communicate basic functional needs. Aphasia training which includes therapy directed at both receptive and expressive language deficits has been found to be of benefit in language recovery.³⁴ Aphasia treatment provided in the acute phase (1-3 months after stroke) with a greater intensity (increased number of hours of therapy) has been shown to provide the greatest benefit.³⁴ Family education with the aphasic patient is important and there is limited evidence to suggest that training communication partners may allow greater social interaction and conversation.³⁵

Swallowing Impairment

Swallowing function must be evaluated in each patient following a stroke. Dysphagia that is suspected on initial screening will often require radiologic assessment with a modified barium swallow to specifically determine the dysfunctional areas and help guide dietary recommendations. The speech language pathologist's treatment focus includes modification of food and liquid consistency, instruction in compensatory swallowing techniques and specific therapeutic modalities to improve coordination and strengthen oral-pharyngeal muscles.

Spasticity

Spasticity is a common problem that occurs after stroke and can affect the upper and lower extremity and may cause significant physical disability and pain. Spasticity is the disinhibition of central nervous system tone-regulating mechanisms which results in significantly increased tone and reduction in both passive and active range of motion in the affected extremity. Spasticity can impair gait and reduce the available range of an extremity, thus impeding hygiene, dressing, and other functional tasks. The initial approach to treatment of spasticity is two-fold: physical modalities which include stretching, weight-bearing, and splinting and oral medications such as tizanidine, baclofen or dantrolene. Unfortunately, the side effect profiles of oral medications include drowsiness and hypotension, which may limit one's ability to adequately titrate the drug to its full therapeutic benefit. As a result, alternative techniques may be required to adequately control the abnormal tone that is impairing functional activity. Certain patients may benefit from selective muscle injection with botulinum toxin to reduce spasticity, improve range of motion, decrease pain, and ultimately improve function. Botulinum toxin injection has been shown to reduce spasticity and improve gait recovery.³⁶ In the more generalized severe levels of spasticity that are unresponsive to oral medication or local botulinum toxin injection, consideration of intrathecal baclofen administration with an implantable pump may be warranted.

Affective Issues

Depression is a significant sequela of stroke and has been reported to occur at some point in 33% of stroke survivors.³⁷ It is important that stroke survivors be monitored for this during their recovery, as depressive symptoms may occur at any time. Depression may impair functional recovery.³⁸ Appropriate counseling and medications, such as selective serotonin reuptake inhibitors, should be considered in patients exhibiting signs and symptoms of depression.

Conclusion

Stroke has devastating effects on the health of our society. Rehabilitation plays a key role in improving outcome from stroke. Rehabilitation occurs in multiple physical domains. Scientific study is beginning to define the mechanisms that underlie neural and cortical recovery from stroke. The developing evidence-based methodologies that are becoming the foundation for stroke rehabilitation, will likely improve the efficacy and efficiency of rehabilitation interventions. Through this process, stroke survivors will continue to experience better functional outcomes and ultimately, a better quality of life.

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This is what a stroke like feels

Brooks Rehabilitation recently sponsored "When Stroke Strikes, A Community Health Summit," on May 24 at the University of North Florida's University Center. Featured speakers were Dr. Scott Silliman, Associate Professor of Neurology, University of Florida and Director of the Comprehensive Stroke Program at Shands Jacksonville; Dr. Thomas Brott, Director of Research, Mayo Clinic Jacksonville and Professor of Neurology, Mayo Clinic College of Medicine; and Dr. Trevor Paris, Medical Director, Stroke Program, Brooks Rehabilitation Hospital and a Board-certified specialist in Physical Medicine and Rehabilitation.

Attendees heard about the latest in stroke prevention, treatment and rehabilitation. They received answers to questions such as "If a stroke were to happen to you or a loved one right now, would you recognize the symptoms?" and "Would you know what to do or what type of treatment to ask for?" Presenters emphasized that understanding why a stroke occurs and what one does if it happens can have a significant impact on one's ability to recover.

For more information on stroke research at Brooks, please visit brookscenter.org.