Rehabilitation of a patient with stroke

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ABSTRACT

Stroke is a significant cause of long-term disability world-wide. The post-stroke disabilities are due to loss of locomotion, activity of daily living, cognition and communication skills. Rehabilitation is an integral part of medical management and continues longitudinally through acute care, post-acute care and community reintegration. The objectives of stroke rehabilitation are to maximize the functional independence, minimize the disabilities, reintegrate back into the home and community and improve the self-esteem of patient. A comprehensive stroke rehabilitation service should provide early assessment of impairments and disabilities, management and prevention of complications and well-organized rehabilitation program in both in-patient and out-patient settings. A multidisciplinary or interdisciplinary team approach is necessary to reduce the post-stroke disabilities. It has many members, including physicians, physical therapists, occupational therapists, speech and language pathologists, orthotist, psychotherapists, social workers, vocational rehabilitation therapists, rehabilitation nurse, patients, families and other caregivers. Physicians caring for patients with stroke during rehabilitation must be aware of potential medical complications, as well as a number of special problems that may complicate recovery, including cognitive deficits, aphasia, dysphagia, urinary incontinence, shoulder pain, spasticity, falls and depression. Involvement of patient and caregivers in the rehabilitation process is essential. This article outlines the salient features of the early comprehensive rehabilitation after stroke.

Key words: Disability, rehabilitation, stroke

INTRODUCTION

Stroke is the second common cause of disability after dementia in elderly population.[1] It causes tremendous impact on survivors and family members.[2,3] As per World Health Organization Disability Assessment Schedule, 72.5% stroke survivors are severely disabled in rural India.[4] The post-stroke disabilities are primarily due to loss of locomotion, activity of daily living (ADL), cognition and communication skills.[5] During the 1st week, 78-90% patients become partial to completely dependent on family members for daily activities and at the end of 6 months, 40-62% patients remain dependent.[5] The incidence of complete dependence in ADL decreases from 58% at 1 week to 9% at 6 months among stroke survivors.[6]

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Well-organized rehabilitation program, initiated immediately after stroke, enhance the recovery process and minimize the functional disability in post-stroke patients. Hence it is very important to make a proper guideline for the rehabilitation of stroke patients with multiple disabilities, especially during the early phases of post-stroke periods.

This article has been adapted from various literatures and outlines briefly the problems experienced by stroke survivors and provides a summary of the early comprehensive rehabilitation post-stroke.

OBJECTIVES OF REHABILITATION

The objectives of stroke rehabilitation are to maximize the functional independence, reintegrate patients back into the home and community and improve the self-esteem of patient.[7] The ultimate goal is to improve the quality-of-life of patient.

The-team-approach

Stroke patients often suffer from multiple disabilities and hence, require either an interdisciplinary[8] or

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multidisciplinary[8,9] team approach. An interdisciplinary or multidisciplinary team may have many members, including physicians, physical therapists, occupational therapists, speech-language pathologists, rehabilitation nurses, social workers, psychologists, vocational councilors, orthotists and caregivers.[8] Role of individual professions in the team has been described in Figure 1. The primary treatment goals and strategies are made by all the team members jointly for each stroke patient. Relevant goals are set, for the optimum recovery of patients within their social situations, interests and abilities. The family, equipped with knowledge and skills becomes the key support to patient eventually after discharge and returning home.

Stroke patients have better outcome if treated in specialized stroke care unit as it improves long-term survival and functional status of the patients.[9-12] Stroke Unit Trialists' Collaboration[12] defined stroke unit as "organized inpatient (stroke unit) care, when compared with conventional care, was best characterized by coordinated multidisciplinary rehabilitation, programs of education and training in stroke and specialization of medical and nursing staff." Success of the stroke rehabilitation depends on detailed assessment of medical problems, impairments and disabilities.[7] Some of the standard assessment scales, used in various studies have been mentioned in Table 1.

MEDICAL COMPLICATIONS

There is a high incidence of coexisting medical disorders, ranging from 59% to 95%.[29,30] Sackley *et al.*[31] reported

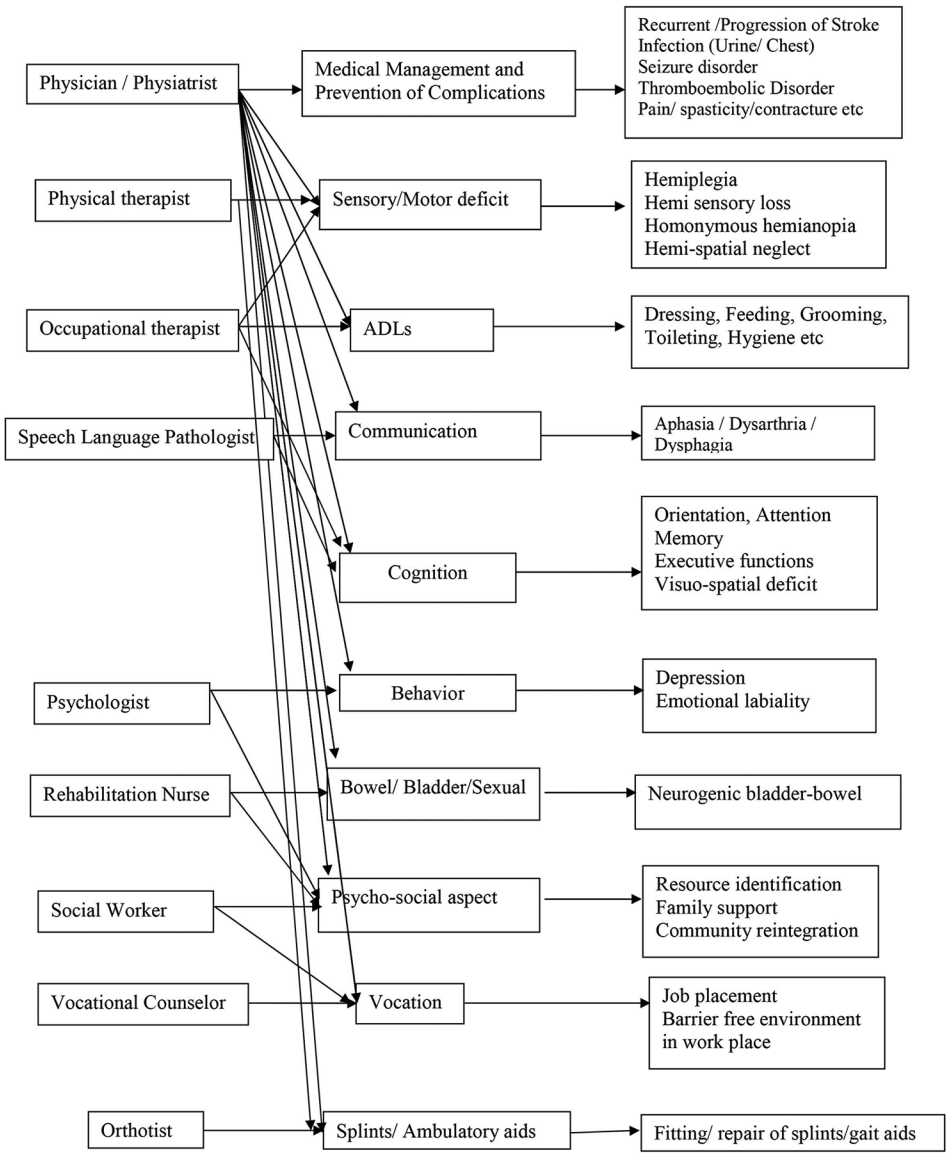

Figure 1: Role of professions in stroke rehabilitation

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Table 1: Some of the standard assessment scales, used in various studies for stroke patients

Assessment	Commonly used scales
Level-of consciousness	Glasgow coma scale[13]
Deficits in stroke	National Institutes of Health Stroke Scale,[14] canadian neurological scale[15]
Global disability in stroke	Rankin scale[16]
Mental status screening	Folstein mini-mental state examination,[17] Neurobehavioral cognition status exam[18]
Assessment of functional independence	Functional independence measure,[19] Barthel index,[20] Fugl-Meyer motor assessment scale,[21] Motricity index,[22] Rivermead mobility index[23]
Balance assessment	Berg balance scale[24]
Assessment of speech and language	Boston diagnostic aphasia examination,[25] Western aphasia battery,[26] Porch index of communicative ability[27]
Assessment of depression	Beck depression inventory[28]

that stroke patients who are more functionally dependent have a greater tendency to develop more number of complications. Outcome of the stroke patients largely depend on the prevention and timely management of complications.[11] Indredavik *et al.*[32] reported that pain, progressing stroke, infections, myocardial infarction and falls are the predominant causes of complications. Literature[2,3] has mentioned that other complications such as shoulder pain, deep venous thrombosis (DVTs), pulmonary embolism (PE), stroke recurrence, seizure and pressure sores also occur very frequently after stroke.

Shoulder pain, prevalence ranges from 34%[3] to 84%[33] can develop within weeks or months after stroke.[3] Incidence of complex regional pain syndrome- type I and shoulder subluxation were found 12.5[34]-70%[3] and 50%[35] respectively. Most of the time, shoulder subluxation is associated with shoulder pain.[3] Range of motion exercises[2,3] neuromuscular electrical stimulation,[3] shoulder tapping[36] and shoulder hemisling[2,3] are effective to in reducing shoulder pain and preventing subluxation.

Kelly *et al.*[37] reported DVTs, which is very common in the paralyzed leg, can develop as early as the 2nd day, with the peak incidence between 2 and 7 days. In absence of heparin prophylaxis, the incidence of DVT is around 50% in 2 weeks.[37] Incidences of clinically apparent PE in stroke patients of 10-13%.[37] Untreated, clinically apparent DVT is associated with mortality from PE of up to 37%.[37] The incidence of post-thrombotic syndrome, characterized by persistent pain and swelling, with or without venous ulceration, approaches to 90% inpatients with untreated symptomatic DVT.[37] Unfractionated heparin and low molecular weight heparin were found to be equally effective in the prevention and treatment of venous thromboembolism.[37] Though there have been no large studies on graded elastic compression stockings[37] and intermittent pneumatic compression,[2,37] they were found to be effective in preventing DVT.

Spasticity, appears shortly after stroke, may remain in as many as 40% patients, even after 3-6 months.[3] Spasticity can be managed with anti-spastic medications along with positioning of the limbs, physical therapy, serial casting, splinting and electrical stimulation. Nerve blocks (phenol injection),[3] focal injection of botulinum toxin[3] and intrathecal baclofen[3] were found to be effective in stroke patients in reducing spasticity. Monitoring the effects of antispastic medications are very essential as reduced spasticity may decrease gait performance in those patients who have started walking with the help of certain level of spasticity. If spasticity remains untreated, increased resting and dynamic tone may lead to soft-tissue contracture.[3] Literatures[2,3] has reported that static resting splints for hand (e.g., wrist cock-up split) and ankle-foot (e.g., ankle foot orthosis) can significantly reduce tone and prevent contracture.

REHABILITATION TEAM MANAGEMENT OF SPECIFIC PROBLEMS

Mobility and ADL

Stroke rehabilitation begins as soon as the diagnosis is established and life-threatening problems are under control[2,3] Paolucci *et al.*[38] found strong inverse relationship between the starting date of therapy and functional outcome. Literature[2,3] has suggested to start passive range of motion exercises to the paretic limb at the earliest to prevent contractures. Passive mobilization must be progressed quickly to active participation by patient in the activities[2] Knecht *et al.*[11] at his review advised to take the stroke patients "out of bed!" within 2 days of achieving hemodynamic stability. Mobilization over the edge of the bed into a wheelchair, with repeated practicing of transfers, can be supplemented by wheelchair training and therapeutic standing.[11] Concurrently, patients can be encouraged to participate in self-care activities like self-feeding, dressing and grooming.[2] Duncan *et al.*[8] has reported that early mobilization reduces the risks of contracture formation, skin breakdown, DVTs, gastroesophageal regurgitation, aspiration pneumonia and orthostatic intolerance. It also has a strong positive psychological effect on the patient.[2]

Physical therapy helps in motor recovery of the stroke patients. Conventional physical therapy[5] methods consist of stretching and strengthening exercises. Neurophysiological approaches[3,5,11] (e.g., proprioceptive

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neuromuscular facilitation technique, Bobath's neuro-developmental technique approach, Brunmstorm's technique and Rood's approach) stress on enhancement of the natural recovery process, facilitate recovery of motor control through different strategies. In task-specific repetitive approach,[11] the motor tasks to be learned are practiced repeatedly as many times as possible.

Studies[39,40] on role of drug, fluoxetine on motor skills have shown that early prescription of fluoxetine may enhance motor skills on the affected side in post-stroke patients with moderate to severe disability.

Functional electrical stimulation (FES), applied within 1st few weeks of stroke[8] promotes active muscle contraction, improves muscle strength, prevents disuse atrophy, reduces muscle tone and spasms and helps in motor relearning (posture, standing and walking).[41] FES can be used to deliver electrical stimulation to the ankle dorsiflexor muscles and supraspinatus and posterior deltoid muscles to correct foot drop[41] and to prevent and manage the shoulder subluxation.[5,42-44] Studies[1,45-47] on FES based orthosis have shown that it enhances walking speed and reduces number of falls and patient's effort.

Nair and Taly[5] reported that electromyographic (EMG) biofeedback can be used to improve arm and hand functions in hemiplegic patients. EMG biofeedback involves recording surface EMG from the test muscle and using auditory or visual display of the EMG signal as feedback to patient on the ongoing activity status of the muscle. Studies[48-50] have shown that virtual reality technology significantly improve the motor function of paretic upper and lower limbs. The Rehabilitation Gaming System[48] uses virtual reality technology to address the motor and cognitive deficits.

Restoration of ability of independent walking and improvement of balance-coordination are the primary goals of gait rehabilitation for patients who are unable to walk independently post-stroke.[51] Once stroke patients start ambulating in wheelchair, sitting unsupported at the edge of the bed and tolerate verticalization for at least 10 min, patients are made to stand inside the hemibar with or without an ankle foot orthosis. Nair and Taly[5] has suggested that initially during gait training, therapist can help moving the patient's paretic limb with therapist own leg. Once patient start walking around 25-50 feet length inside the hemibar, they are progressed to gait training with a walking aid (e.g., Forearm Crutch, cane with four points, walker) outside the hemibar. Once patients are comfortable in walking on even surface, they can be planned for gait training on uneven surface, ramps and stairs. Studies[52-54] have shown that partial body weight supported treadmill training results in better walking and postural abilities in some non-ambulatory hemiplegic patients and improves their walking speed and endurance.

One of the major objectives of stroke rehabilitation is to maximize the functional independence for ADLs.[2] An occupational therapist train patients in improving the ability to carry out ADL and using of various assistive devices within a contextually appropriate environment. Physical and occupation therapists try to train the patient returning arm and hand function with repetitive practice, paying special attention to strength, coordination and speed and to integrate hand function into these everyday activities.[11,55] Constrained induced movement therapy[11,56] mirror therapy,[57,58] robot-assisted exercise training[56,59] and virtual reality exercise training[60] may help to improve voluntary control of the hand. Botulinum toxin injections can be used to treat spastic flexion, with the aim of reducing muscle tone, facilitating hand care and alleviating pain.[11,61]

Communication disorder

Kelly *et al.*[62] reported in Cochrane review that around one-third of all stroke patients experience aphasia. Hoffman and Chen[63] reported, among aphasia subtypes, Broca, global, anomic and subcortical aphasias account the major subtypes. Language therapy is based on the detailed evaluation of the stroke patient's cognitive and linguistic capabilities and deficits. Speech therapists attempt to improve communicative ability by circumventing the language deficit or by helping the patients to compensate. Constraint-induced language therapy protocols[64,65] can improve functional communication in chronic aphasia after stroke. Specific techniques (e.g. computer based therapy program, augmentative and alternate communication devices)[66] improve comprehension, word or phoneme retrieval and gestures to supplement verbal communication. There is also evidence that low frequency repetitive transcranial magnetic stimulation[67] can improve language abilities in patients with chronic non-fluent aphasia.

Bakheit[68] has reported that dopamine agonists (Bromocriptine), piracetam (Nootropil), amphetamines and donepezil, may help in the treatment of aphasia in both acute and chronic stages. However, Ozeren *et al.*[69] Ashtary *et al.*[70] did not find any significant improvement with Bromocriptine. Further studies are warranted to see the efficacy of pharmacological agents in communication disorder.

Dysarthria can also occur too frequently after stroke.[71] Oral musculature exercises, biofeedback or

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a voice amplifier, compensatory strategies, to change intensity and increase loudness; palatal lift to compensate for velopharyngeal incompetency, can improve dysarthria. Interventions for dyspraxia of speech include modeling, visual cueing, integral stimulation and articulatory placement cueing.[72]

Cognitive and behavioral disorder

Cognitive impairments have been reported in 74% of patients with cortical stroke and <50% in sub-cortical or infratentorial stroke.[67] Cumming *et al*.[67] reported that infarcts in the middle cerebral artery territory are more prone to develop cognitive impairment. It commonly involves attention, orientation, memory, language, executive functions, visuospatial ability. Cognitive rehabilitation can be either compensatory or restorative. Compensatory approaches involve adapting the external environment to altered cognitive abilities, where as restorative approaches aim for the compelling goal of direct restoration of function.[67]

The site and size of a brain lesion determine the severity of behavioral and psychological changes.[2] Patients with the left anterior hemisphere lesions are more likely to be depressed, whereas patients with right hemisphere lesions are more likely to be unduly cheerful. Emotional labiality is more common in patients with right hemisphere lesions. Cognitive, behavior therapy and/or antidepressants may be used for patients with anxiety disorders. Antidepressants and/or psychological interventions may be provided for patients with depression or emotional labiality.[2]

Visuo-spatial deficits

The incidence of visual deficits following stroke ranges from 20% to 68%.[73] Homonymous hemianopia[74] is very common after stroke. Schofield and Leff[74] reported that optical therapies, eye movement-therapies and visual field restitution therapies can improve the visual outcome of the stroke patients. Keane *et al*.[75] reported that Fresnel prisms adaptation to eyeglasses significantly improve vision in patients with complete hemianopia. Fresnel prisms shift images in the affected hemi visual field toward the center of the retina.[76]

Hemispatial neglect syndrome (occurs in approximately 23%) compromises functional outcome of the left hemiparesis patients.[77,78] It arises due to damage of the right inferior parietal lobule, the visuomotor component to the right dorsolateral prefrontal cortex and the object-centered component to the deep temporal lobe regions.[67] It manifests heterogeneously in clinical deficits such as poor visual exploration to the left, inaccurate assessment of the midpoint of a line, left limb hypokinesis and anosognosia.[79] Therapy is directed at retraining, with repetitive exercises or use of compensatory techniques, to teach new methods of task completion. Therapies include visual scanning, vestibular stimulation of the left side, sensory activation of the left limb, environmental adaptations and transcranial magnetic stimulation of the overactive left hemisphere.[79]

Swallowing disorder

Dysphagia, is very common after stroke, frequencies ranging from 19% to 81%,[80] is more prominent in brain stem stroke.[81] Early detection of dysphagia can reduce the incidence of pulmonary complications and even mortality.[81] The presence of dysphagia can be identified by cursory screening technique, clinical testing (e.g., cranial nerve examination and swallowing assessment with variety of modified liquids and solids) and video-fluoroscopy swallowing test.[81] McCullough and Kim[82] reported that compensatory strategies such as the Mendelsohn maneuver and voluntary prolongation of laryngeal elevation improve upper esophageal sphincter opening and bolus flow during swallowing. Consistency modification of liquid and solid foods, oromotor exercises for oral musculature, thermal-tactile stimulation,[83] electrical stimulation[83] and transcranial direct stimulation[84] facilitate safe swallow.[83] Bath *et al*.[85] reported percutaneous endoscopic gastrostomy feeding can improve the nutritional status and outcome of the severely disabled patients.

BOWEL-BLADDER DYSFUNCTION

Irregular bowel not only causes discomfort, but it can also affect a patient's physical and psychological well-being. Studies[6,86,87] have reported 31-40% of stroke patients experience bowel incontinence at the time of admission, whereas 30-60%[88] patient experience constipation after stroke. Constipation can be prevented by diet modification (adequate fluid and fiber intake), stool softeners, structured bowel training program, abdominal massage and increased mobility. Structured bowel-training program includes timely rectal suppositories and digital stimulation.

Urinary incontinence is common (ranging from 28% to 79%)[89] after stroke, with Detrusor overactivity is the most common.[89] Studies[90-92] have shown that lesions in the frontal cortex or the frontoparietal lobes and internal capsule are associated with urinary dysfunction after stroke. The incidence of incontinence depends on the time interval after the stroke. Gelber *et al*.[93] have suggested three major mechanisms responsible urinary incontinence in stroke patients: Disruption of neuro micturition pathways (overactive detrusor and urge

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incontinence); stroke-related cognitive and language deficits, with normal bladder function; and concurrent neuropathy or medication use (underactive detrusor and overflow incontinence). Urinary incontinence can be managed by scheduled voiding program. The post-stroke patients should be encouraged to pass urine every 4 hourly by placing the patient on a bedside commode or taking patient to toilet. In event of failure, an external collecting device like a condom catheter for male patients may be used.

SEXUAL DYSFUNCTION

From 40% to 70% of stroke survivors may have sexual dysfunction.[3] Psychological factors (e.g., fear, anxiety, depression and discomfort) rather than organic and impairments such as sensory-motor deficits, severe spasticity and pain can cause sexual problems for stroke patients.[3] Regular counseling regarding positioning, techniques and assurance may increase the stroke patient's confidence and self-esteem.

VOCATIONAL AND PSYCHO-SOCIAL REHABILITATION

Although stroke is predominantly a disease of older individuals, a significant portion of stroke survivors are of working age. Prevalence of stroke in India has been reported 27-34/100,000 in the 35-44 age group.[1] Once ADL have been mastered, vocational counseling may assist individuals seeking to return to work.

About 34-52% of family members of stroke patients suffer from depression.[5] Spouse, family and patient's own psychological adjustment and coping mechanisms play important role in ultimate outcome of the stroke patients. Health education about disease itself, risk-factors, life-style modification and sexual counseling can help patients with stroke and their families to cope up with the disabilities.

Follow-up is an important tool, which helps the rehabilitation team to evaluate and improve the quality of services provided. Common follow-up strategies include the out-patient services, home visits. Literature[5] has reported that good family as well as financial support, higher educational levels, early initiation of rehabilitation program and expertise of the center with stroke rehabilitation can result in good outcome of the stroke patients.

CONCLUSION

Stroke patients can have a wide range of medical, physical, mental, cognitive and social problems. Hence, it is very necessary to start well-organized comprehensive rehabilitation program along with medical management. The comprehensive assessment of medical problems, impairments and disabilities, active physiological management, early mobilization, skilled nursing care and tightly organized rehabilitation schedule can significantly improve thequality-of-life of stoke patients. An overview of this multidisciplinary team model attempts to describe comprehensive rehabilitation program as a treatment standard for patients with multiple disabilities following post-stroke. Further experimental and clinical studies are required to expand our knowledge and improve the efficacy of rehabilitation.

REFERENCES

1. Khattar B, Banerjee A, Reddi R, Dutta A. Feasibility of functional electrical stimulation-assisted neurorehabilitation following stroke in India: A case series. Case Rep Neurol Med 2012;2012:830873.
2. DeLisa JA. Physical Medicine and Rehabilitation: Principles and Practice. 4th ed. Philadelphia: Lippincott Williams and Wilkins; 2005. p. 1655-76.
3. Braddom RL. Physical Medicine and Rehabilitation. 4th ed. Philadelphia: Elsevier Health Sciences; 2010. p. 1177-222.
4. Ferri CP, Schoenborn C, Kalra L, Acosta D, Guerra M, Huang Y, *et al*. Prevalence of stroke and related burden among older people living in Latin America, India and China. J Neurol Neurosurg Psychiatry 2011;82:1074-82.
5. Nair KP, Taly AB. Stroke rehabilitation: Traditional and modern approaches. Neurol India 2002;50 Suppl: S85-93.
6. Wade DT, Hewer RL. Functional abilities after stroke: Measurement, natural history and prognosis. J Neurol Neurosurg Psychiatry 1987;50:177-82.
7. Gresham GE, Alexander D, Bishop DS, Giuliani C, Goldberg G, Holland A, *et al*. American heart association prevention Conference. IV. Prevention and rehabilitation of stroke. Rehabilitation. Stroke 1997;28:1522-6.
8. Duncan PW, Zorowitz R, Bates B, Choi JY, Glasberg JJ, Graham GD, *et al*. Management of adult stroke rehabilitation care: A clinical practice guideline. Stroke 2005;36:e100-43.
9. Langhorne P, Pollock A. Stroke unit trialists' collaboration. What are the components of effective stroke unit care? Age Ageing 2002;31:365-71.
10. Indredavik B, Bakke F, Slordahl SA, Rokseth R, Hâheim LL. Stroke unit treatment. 10-year follow-up. Stroke 1999;30:1524-7.
11. Knecht S, Hesse S, Oster P. Rehabilitation after stroke. Dtsch Arztebl Int 2011;108:600-6.
12. Collaborative systematic review of the randomised trials of organised inpatient (stroke unit) care after stroke. Stroke unit trialists' collaboration. BMJ 1997;314:1151-9.
13. Teasdale G, Jennett B. Assessment of coma and impaired consciousness. A practical scale. Lancet 1974;2:81-4.
14. Brott T, Adams HP Jr, Olinger CP, Marler JR, Barsan WG, Biller J, *et al*. Measurements of acute cerebral infarction: A clinical examination scale. Stroke 1989;20:864-70.
15. Côté R, Hachinski VC, Shurvell BL, Norris JW, Wolfson C. The Canadian neurological scale: A preliminary study in acute stroke. Stroke 1986;17:731-7.
16. Rankin J. Cerebral vascular accidents in patients over the age of 60. II. Prognosis. Scott Med J 1957;2:200-15.
17. Folstein MF, Folstein SE, McHugh PR. "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res 1975;12:189-98.
18. Kiernan RJ, Mueller J, Langston JW, Van Dyke C. The neurobehavioral cognitive Status examination: A brief but quantitative approach to cognitive assessment. Ann Intern Med 1987;107:481-5.

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19. Keith RA, Granger CV, Hamilton BB, Sherwin FS. The functional independence measure: A new tool for rehabilitation. Adv Clin Rehabil 1987;1:6-18.
20. Mahoney FI, Barthel DW. Functional evaluation: The barthel index. Md State Med J 1965;14:61-5.
21. Fugl-Meyer AR, Jääskö L, Leyman I, Olsson S, Steglind S. The post-stroke hemiplegic patient. 1. A method for evaluation of physical performance. Scand J Rehabil Med 1975;7:13-31.
22. Collin C, Wade D. Assessing motor impairment after stroke: A pilot reliability study. J Neurol Neurosurg Psychiatry 1990;53:576-9. Demeurisse G, Demol O, Robaye E. Motor evaluation in vascular hemiplegia. Eur Neurol 1980;19:382-9.
23. Collen FM, Wade DT, Robb GF, Bradshaw CM. The rivermead mobility index: A further development of the rivermead motor assessment. Int Disabil Stud 1991;13:50-4.
24. Berg KO, Maki BE, Williams JI, Holliday PJ, Wood-Dauphinee SL. Clinical and laboratory measures of postural balance in an elderly population. Arch Phys Med Rehabil 1992;73:1073-80.
25. Goodglass H, Kaplan E. Test procedures and rationale. Manual for the BDAE. Boston Diagnostic Aphasia Examination (BDAE). Ch. 4., 2nd ed, Philadelphia: Lea and Febiger; 1983.
26. Kertesz A. Western Aphasia Battery. New York: Grune and Stratton; 1982.
27. Porch B. Porch index of communicative ability (PICA). Palo Alto: Consulting Psychologists Press; 1981.
28. Beck AT, Ward CH, Mendelson M, Mock J, Erbaugh J. An inventory for measuring depression. Arch Gen Psychiatry 1961;4:561-71.
29. Davenport RJ, Dennis MS, Wellwood I, Warlow CP. Complications after acute stroke. Stroke 1996;27:415-20.
30. Johnston KC, Li JY, Lyden PD, Hanson SK, Feasby TE, Adams RJ, *et al*. Medical and neurological complications of ischemic stroke: Experience from the RANTTAS trial. RANTTAS investigators. Stroke 1998;29:447-53.
31. Sackley C, Brittle N, Patel S, Ellins J, Scott M, Wright C, *et al*. The prevalence of joint contractures, pressure sores, painful shoulder, other pain, falls, and depression in the year after a severely disabling stroke. Stroke 2008;39:3329-34.
32. Indredavik B, Rohweder G, Naalsund E, Lydersen S. Medical complications in a comprehensive stroke unit and an early supported discharge service. Stroke 2008;39:414-20.
33. Najenson T, Yacubovich E, Pikielni SS. Rotator cuff injury in shoulder joints of hemiplegic patients. Scand J Rehabil Med 1971;3:131-7.
34. Davis SW, Petrillo CR, Eichberg RD, Chu DS. Shoulder-hand syndrome in a hemiplegic population: A 5-year retrospective study. Arch Phys Med Rehabil 1977;58:353-6.
35. Van Ouwenaller C, Laplace PM, Chantraine A. Painful shoulder in hemiplegia. Arch Phys Med Rehabil 1986;67:23-6.
36. Pandian JD, Kaur P, Arora R, Vishwambaran DK, Toor G, Mathangi S, *et al*. Shoulder taping reduces injury and pain in stroke patients: Randomized controlled trial. Neurology 2013;80:528-32.
37. Kelly J, Rudd A, Lewis R, Hunt BJ. Venous thromboembolism after acute stroke. Stroke 2001;32:262-7.
38. Paolucci S, Antonucci G, Grasso MG, Morelli D, Troisi E, Coiro P, *et al*. Early versus delayed inpatient stroke rehabilitation: A matched comparison conducted in Italy. Arch Phys Med Rehabil 2000;81:695-700.
39. Chollet F, Tardy J, Albucher JF, Thalamas C, Berard E, Lamy C, *et al*. Fluoxetine for motor recovery after acute ischaemic stroke (FLAME): A randomised placebo-controlled trial. Lancet Neurol 2011;10:123-30.
40. Pariente J, Loubinoux I, Carel C, Albucher JF, Leger A, Manelfe C, *et al*. Fluoxetine modulates motor performance and cerebral activation of patients recovering from stroke. Ann Neurol 2001;50:718-29.
41. Kesar TM, Perumal R, Jancosko A, Reisman DS, Rudolph KS, Higginson JS, *et al*. Novel patterns of functional electrical stimulation have an immediate effect on dorsiflexor muscle function during gait for people poststroke. Phys Ther 2010;90:55-66.
42. Ada L, Foongchomcheay A. Efficacy of electrical stimulation in preventing or reducing subluxation of the shoulder after stroke: A meta-analysis. Aust J Physiother 2002;48:257-67.
43. Koyuncu E, Nakipoğlu-Yüzer GF, Doğan A, Ozgirgin N. The effectiveness of functional electrical stimulation for the treatment of shoulder subluxation and shoulder pain in hemiplegic patients: A randomized controlled trial. Disabil Rehabil 2010;32:560-6.
44. Price CI, Pandyan AD. Electrical stimulation for preventing and treating post-stroke shoulder pain. Cochrane Database Syst Rev 2000;(4): CD001698.
45. Merletti R, Andina A, Galante M, Furlan I. Clinical experience of electronic peroneal stimulators in 50 hemiparetic patients. Scand J Rehabil Med 1979;11:111-21.
46. Sheffler LR, Hennessey MT, Naples GG, Chae J. Peroneal nerve stimulation versus an ankle foot orthosis for correction of footdrop in stroke: Impact on functional ambulation. Neurorehabil Neural Repair 2006;20:355-60.
47. Hausdorff JM, Ring H. Effects of a new radio frequency-controlled neuroprosthesis on gait symmetry and rhythmicity in patients with chronic hemiparesis. Am J Phys Med Rehabil 2008;87:4-13.
48. Cameirão MS, Badia SB, Oller ED, Verschure PF. Neurorehabilitation using the virtual reality based rehabilitation gaming system: Methodology, design, psychometrics, usability and validation. J Neuroeng Rehabil 2010;7:48.
49. Deutsch JE, Merians AS, Adamovich S, Poizner H, Burdea GC. Development and application of virtual reality technology to improve hand use and gait of individuals post-stroke. Restor Neurol Neurosci 2004;22:371-86.
50. Mirelman A, Patritti BL, Bonato P, Deutsch JE. Effects of virtual reality training on gait biomechanics of individuals post-stroke. Gait Posture 2010;31:433-7.
51. Mehrholz J, Elsner B, Werner C, Kugler J, Pohl M. Electromechanical-assisted training for walking after stroke. Cochrane Database Syst Rev 2013;7:CD006185.
52. Ada L, Dean CM, Vargas J, Ennis S. Mechanically assisted walking with body weight support results in more independent walking than assisted overground walking in non-ambulatory patients early after stroke: A systematic review. J Physiother 2010;56:153-61.
53. Barbeau H, Visintin M. Optimal outcomes obtained with body-weight support combined with treadmill training in stroke subjects. Arch Phys Med Rehabil 2003;84:1458-65.
54. Visintin M, Barbeau H, Korner-Bitensky N, Mayo NE. A new approach to retrain gait in stroke patients through body weight support and treadmill stimulation. Stroke 1998;29:1122-8.
55. Platz T. Evidence-based arm rehabilitation – A systematic review of the literature. Nervenarzt 2003;74:841-9.
56. Langhorne P, Bernhardt J, Kwakkel G. Stroke rehabilitation. Lancet 2011;377:1693-702.
57. Yavuzer G, Selles R, Sezer N, Sütbeyaz S, Bussmann JB, Köseoğlu F, *et al*. Mirror therapy improves hand function in subacute stroke: A randomized controlled trial. Arch Phys Med Rehabil 2008;89:393-8.
58. Thieme H, Mehrholz J, Pohl M, Behrens J, Dohle C. Mirror therapy for improving motor function after stroke. Cochrane Database Syst Rev 2012;3:CD008449.
59. Norouzi-Gheidari N, Archambault PS, Fung J. Effects of robot-assisted therapy on stroke rehabilitation in upper limbs: Systematic review and meta-analysis of the literature. J Rehabil Res Dev 2012;49:479-96.
60. Liepert J. Evidence-based methods in motor rehabilitation after stroke. Fortschr Neurol Psychiatr 2012;80:388-93.
61. Ploumis A, Varvarousis D, Konitsiotis S, Beris A. Effectiveness of botulinum toxin injection with and without needle electromyographic guidance for the treatment of spasticity in hemiplegic patients: A randomized controlled trial. (Epub ahead of print May 14, 2013) Disabil Rehabil 2013
62. Kelly H, Brady MC, Enderby P. Speech and language therapy for aphasia following stroke. Cochrane Database Syst Rev 2010;5:CD000425.
63. Hoffmann M, Chen R. The spectrum of aphasia subtypes and etiology in subacute stroke. (Epub ahead of print May 13, 2013) J Stroke Cerebrovasc Dis 2013
64. Cherney LR, Patterson JP, Raymer A, Frymark T, Schooling T. Evidence-based systematic review: Effects of intensity of treatment and constraint-induced language therapy for individuals with stroke-induced aphasia. J Speech Lang Hear Res 2008;51:1282-99.
65. Breier JI, Juranek J, Maher LM, Schmadeke S, Men D, Papanicolaou AC. Behavioral and neurophysiologic response to therapy for chronic aphasia. Arch Phys Med Rehabil 2009;90:2026-33.

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66. Wallace T, Bradshaw A. Technologies and strategies for people with communication problems following brain injury or stroke. Neuro Rehabilitation 2011;28:199-209.
67. Cumming TB, Marshall RS, Lazar RM. Stroke, cognitive deficits, and rehabilitation: Still an incomplete picture. Int J Stroke 2013;8:38-45.
68. Bakheit AM. Drug treatment of poststroke aphasia. Expert Rev Neurother 2004;4:211-7.
69. Ozeren A, Sarica Y, Mavi H, Demirkiran M. Bromocriptine is ineffective in the treatment of chronic nonfluent aphasia. Acta Neurol Belg 1995;95:235-8.
70. Ashtary F, Janghorbani M, Chitsaz A, Reisi M, Bahrami A. A randomized, double-blind trial of bromocriptine efficacy in nonfluent aphasia after stroke. Neurology 2006;66:914-6.
71. Flowers HL, Silver FL, Fang J, Rochon E, Martino R. The incidence, co-occurrence, and predictors of dysphagia, dysarthria, and aphasia after first-ever acute ischemic stroke. J Commun Disord 2013;46:238-48.
72. Rosenbek JC, Lemme ML, Ahern MB, Harris EH, Wertz RT. A treatment for apraxia of speech in adults. J Speech Hear Disord 1973;38:462-72.
73. Hayes A, Chen CS, Clarke G, Thompson A. Functional improvements following the use of the NVT Vision rehabilitation program for patients with hemianopia following stroke. Neuro Rehabilitation 2012;31:19-30.
74. Schofield TM, Leff AP. Rehabilitation of hemianopia. Curr Opin Neurol 2009;22:36-40.
75. Keane S, Turner C, Sherrington C, Beard JR. Use of fresnel prism glasses to treat stroke patients with hemispatial neglect. Arch Phys Med Rehabil 2006;87:1668-72.
76. Mizuno K, Tsuji T, Takebayashi T, Fujiwara T, Hase K, Liu M. Prism adaptation therapy enhances rehabilitation of stroke patients with unilateral spatial neglect: A randomized, controlled trial. Neurorehabil Neural Repair 2011;25:711-20.
77. Pedersen PM, Jørgensen HS, Nakayama H, Raaschou HO, Olsen TS. Hemineglect in acute stroke – Incidence and prognostic implications. The Copenhagen stroke study. Am J Phys Med Rehabil 1997;76:122-7.
78. Rode G, Rossetti Y, Badan M, Boisson D. Role of rehabilitation in hemineglect syndromes. Rev Neurol (Paris) 2001;157:497-505.
79. Marshall RS. Rehabilitation approaches to hemineglect. Neurologist 2009;15:185-92.
80. Meng NH, Wang TG, Lien IN. Dysphagia in patients with brainstem stroke: Incidence and outcome. Am J Phys Med Rehabil 2000;79:170-5.
81. Martino R, Foley N, Bhogal S, Diamant N, Speechley M, Teasell R. Dysphagia after stroke: Incidence, diagnosis, and pulmonary complications. Stroke 2005;36:2756-63.
82. McCullough GH, Kim Y. Effects of the Mendelsohn maneuver on extent of hyoid movement and UES opening post-stroke.(Epub ahead of print March 14, 2013) Dysphagia 2013
83. Geeganage C, Beavan J, Ellender S, Bath PM. Interventions for dysphagia and nutritional support in acute and subacute stroke. Cochrane Database Syst Rev 2012;10:CD000323.
84. Shigematsu T, Fujishima I, Ohno K. Transcranial direct current stimulation improves swallowing function in stroke patients. Neurorehabil Neural Repair 2013;27:363-9.
85. Bath PM, Bath FJ, Smithard DG. Interventions for dysphagia in acute stroke. Cochrane Database Syst Rev 2012;10:CD000323.
86. Nakayama H, Jørgensen HS, Pedersen PM, Raaschou HO, Olsen TS. Prevalence and risk factors of incontinence after stroke. The Copenhagen stroke study. Stroke 1997;28:58-62.
87. Brittain KR, Peet SM, Castleden CM. Stroke and incontinence. Stroke 1998;29:524-8.
88. Harari D, Norton C, Lockwood L, Swift C. Treatment of constipation and fecal incontinence in stroke patients: Randomized controlled trial. Stroke 2004;35:2549-55.
89. McKenzie P, Badlani GH. The incidence and etiology of overactive bladder in patients after cerebrovascular accident. Curr Urol Rep 2012;13:402-6.
90. Tsuchida S, Noto H, Yamaguchi O, Itoh M. Urodynamic studies on hemiplegic patients after cerebrovascular accident. Urology 1983;21:315-8.
91. Sakakibara R, Hattori T, Yasuda K, Yamanishi T. Micturitional disturbance after acute hemispheric stroke: Analysis of the lesion site by CT and MRI. J Neurol Sci 1996;137:47-56.
92. Burney TL, Senapati M, Desai S, Choudhary ST, Badlani GH. Effects of cerebrovascular accident on micturition. Urol Clin North Am 1996;23:483-90.
93. Gelber DA, Good DC, Laven LJ, Verhulst SJ. Causes of urinary incontinence after acute hemispheric stroke. Stroke 1993;24:378-82.

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