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Editorial Open Access

Emerging Technologies in Stroke Rehabilitation

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Rehabilitation is the process of recovery of skills by an injured or ill person so as to regain his maximum independence and function in a normal or as near normal manner as possible. The goal is to decrease long-term disability. For example, rehabilitation after a stroke may help the patient walk and speak clearly again. The word comes from the Latin "rehabilitare" meaning to make fit again. Rehabilitation medicine extends from the days of inpatient care to the care given by physiatrist.

The blockage of an artery in the brain by a clot (thrombosis) is the most common cause of a stroke. The part of the brain that is supplied by the clotted blood vessel is then deprived of blood and oxygen. As a result of the deprived blood and oxygen, the cells of that part of the brain die and the part of the body that it controls stops working. Stroke, also referred to as cerebrovascular disease is the leading cause of long-term disability in the United States, increasing the costs of post-acute care and caregiver burden [3,4]. Approximately 87% of the 5.7 million deaths worldwide annually attributable to stroke occur in low-income and middle-income countries [5]. Some of the symptoms of cerebrovascular disease include vision impairment, depression, impaired speech, paralysis, drooling or difficulty eating or swallowing, unusual movements, and seizures to name a few.

The process of stroke rehabilitation involves various professionals such as physician, nurse, occupational therapist, and speech language pathologists [6]. For some stroke survivors, rehabilitation will be a continuous process to maintain and refine skills and could involve working with specialists for months or years after the stroke. Rehabilitation involves strengthening of both weak and intact extremities, use of aiding devices, and modification of environment at home and place of work, and prevention of disability in future [7]. Nowadays, translational science is also considered as an important part of the rehabilitation process. This is because differences in the recovery process between patients are due to differences in the brain networks underlying the desired behavior [8]. Rehabilitation experts conform to the general view that the most important element in any rehabilitation program is carefully supervised, well focused, repetitive practice. The next few paragraphs will discuss emerging and upcoming technologies in stroke rehabilitation.

Constraint induced movement therapy

Developed and studied by Knapp [9], Constraint induced movement therapy (CIMT) is based on the fact that a person with an physical or speech impairment develops a "learned nonuse" by compensating for their lost function with other means such as using an unaffected limb by a paralyzed individual or a drawing by an individual with aphasia [10]. In constraint induced movement therapy, the normal limb is constrained with a glove or sling and the patient is forced to use their affected limb. In various CIMT studies, there was a great improvement in hemiparetic limb function. A similar approach based on the concept of CIMT known as Constraint induced aphasia therapy (CIPT) was also devised. Here the individuals are encouraged to use their remaining verbal abilities to succeed in their communication [11]. Mention has to be made regarding various noninvasive brain stimulation technologies such as transcranial magnetic or current stimulation which may improve language performance in poststroke aphasia [12,13]. It is believed that CIMT works by the mechanism of increased neuroplasticity which normally occurs during childhood development, after physical injury such as loss of a limb or sense organ, and during restoration of learning skills.

In CIMT, the patients undergo training involving repetitive movements known as "shaping" for 7 hours/day (with intervals of course) for all weekdays during 2-3 week period [14]. A device that allows patients to undergo training at home without direct supervision could make CIMT more accessible for people suffering with stroke injuries. This could significantly cut down the cost of the therapy. It is still debatable whether submission to such an intensive training protocol is possible without face-to-face interaction and motivation from therapists and trainers.

Body-weight-supported gait training

"Body weight supported" (BWS) locomotion training is a treatment therapy for individuals having spinal cord injury, stroke, and other neurological disorders that impair movement. The process of BWS involves partial unloading of the limbs and assistance of leg movements during stepping on a treadmill [15]. The effort needed by the therapist to set the paretic limbs and to control weight shift likely limits the intensity of BWS therapy [4]. BWS training improves stepping and walking [16]. Regaining gait by BWS system results in bi-hemispheric activation both in cortical and subcortical regions of the brain [17].

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So far the results for BWS training have been mixed with some studies indicating treadmill training and manual assistance failing to show superior gait function and walking in stroke patients [18]. In another study walking ability positively correlated with gait ability in stroke patients [19]. Use of both "electromechanical gait trainer" as well as traditional physical therapy significantly improved ambulatory ability in patients [20]. More such treadmill vs elliptical trainer studies are needed in future to arrive at a right therapy regimen for rehabilitation of stroke patients.

Functional electrical stimulation (FES)

In the hemiparetic stroke patients suffering from weakness on one side of their bodies FES could bypass the central nervous system input to the muscles of the affected limb. Electric impulses are given to the peripheral nerve to generate action potentials in motoneurons, which in turn radiates to the muscle causing its contraction [21]. FES therapy was found to be especially effective in the upper extremity to activate the posterior interosseous nerve of the forearm to initiate extension at the wrist.

Robotic-assisted therapies

Robotic-assisted therapies focus on both upper and lower extremities of the body and allow patients to train independently [22]. MIT-MANUS robot developed by the Interactive Motion Technologies Inc., Cambridge, Massachusetts, USA allows patients to accomplish reaching movements in the horizontal plane. Studies indicated that upper extremity robotic treatment results in improved upper extremity motor recovery compared to traditional rehabilitation therapies [23]. One recent study contradicted this claim and found that robot-assisted therapy using MIT-MANUS system did not significantly improve motor function at 12 weeks after initiation of therapy [24]. Lokomat (Hocoma Ag, Volketswil, SZ) is a robotic-assisted lower extremity device providing active control at the hip and knee and passive control at the ankle. Participants who received conventional gait training experienced significantly greater gains in walking speed and distance than those trained on the Lokomat [25]. The studies conducted so far have shown mixed results. Additional trials need to be carried out to confirm if any the significant advantages of using robotic-assisted technologies in rehabilitation.

Knowledge and awareness about stroke and its rehabilitation is increasingly important. Training focused on stroke prevention, care, and rehabilitation has been formalized in developed countries [26]. Stroke units and rehabilitation centers have become quite common in developed countries but not so much in developing countries. The need of the hour is to improve the stroke related education in developing countries. People should be made aware of the various rehabilitation programs that exist in their community. Various programs currently exist which disseminate information related to HIV/AIDS, malaria, and other infectious diseases but not for rehabilitation of stroke victims. The development and implementation of new rehabilitation therapies and the dissemination of new and existing information to the target audience is critical. I am sure the Journal of Bioengineering & Biomedical Science from OMICS Publishing Group will play a major role in this regard.

References

1. Eysenbach G (2006) The open access advantage. Journal of Medical Internet Research 8: e8.
2. Ahuja DS (2010) Open Access Publishing: The Future of Rehabilitation Research. Int. J Physiotherapy and Rehabil 1: 05-08.
3. Taylor TN, Davis PH, Torner JC, Holmes J, Meyer JW, et al. (1996) Lifetime cost of stroke in the United States. Stroke 27: 1459–1466.
4. Hargraves JL, Hadley J (2003) The contribution of insurance coverage and community resources to reducing racial/ethnic disparities in access to care. Health Serv Res 38: 809–829.
5. Strong K, Mathers C, Bonita R (2007) Preventing stroke: saving lives around the world. Lancet Neurol 6: 182–187.
6. Ifejika-Jones NL, Barrett AM (2011) Rehabilitation—Emerging Technologies, Innovative Therapies, and Future Objectives. Neurotherapeutics 8: 452–462.
7. DeLisa JA, Currie DM, Martin GM (2004) Rehabilitation medicine: past, present and future. In: Rehabilitation Medicine: Principles and Practice. DeLisa JA, Gans BM (eds), J.B.Lippincott Company, Philadelphia, pp 3–32.
8. Barrett AM, Levy CE, Rothi LJG (2007) Treatment innovation in rehabilitation of cognitive motor deficits after stroke and brain injury: psychological adjunctive treatments. Am J Phys Med Rehabil 86: 423–425.
9. Knapp HD, Taub E, Berman AJ (1958) Effect of deafferentation on a conditioned avoidance response. Science 128: 842–843.
10. Meinzer M, Elbert T, Djundja D, Taub E, Rockstroh B (2007) Extending the Constraint-Induced Movement Therapy (CIMT) approach to cognitive functions: Constraint-Induced Aphasia Therapy (CIAT) of chronic aphasia. NeuroRehabil 22: 311-318.
11. Friedemann P, Bettina N, Thomas E, Bettina M, Brigitte R, et al. (2001) "Constraint-Induced Therapy of Chronic Aphasia following Stroke". Stroke 32: 1621–1626.
12. Galletta E, Rao P, Barrett AM (2011) Transcranial magnetic stimulation: potential progress for language improvement in aphasia. Topics Stroke Rehabil 18: 87–91.
13. Baker J, Rorden C, Fridriksson J (2010) Using transcranial direct current stimulation (tDCS) to treat stroke patients with aphasia. Stroke 41: 1229–1236.
14. Taub E, Uswatte G, Pidikiti R (1999) Constraint-induced movement therapy: a new family of techniques with broad application to physical rehabilitation -- a clinical review. J of Rehabil Res and Dev 36: 237-251.
15. David R, Peter L, Jack W (2002) Emerging Technologies for Improving Access to Movement Therapy following Neurologic Injury. In: Emerging and Accessible Telecommunications, Information and Healthcare Technologies –Engineering Challenges in Enabling Universal Access (eds) Jack W, Charlie R, Richard S, Gregg V, eds. IEEE Press.
16. Protas EJ, Holmes SA, Qureshy H, Johnson A, Lee D, et.al (2001) "Supported treadmill ambulation training after spinal cord injury: a pilot study," Arch Phys Med Rehabil 82: 825-31.
17. Brandstater ME, de Bruin H, Gowland C, Clark MB (1983) Hemiplegic gait: analysis of temporal variables. Arch Phys Med Rehabil 64: 583–587.
18. Moseley AM, Stark A, Cameron ID, Pollock A (2005) Treadmill training and body weight support for walking after stroke. Cochrane Stroke Group. Cochrane Database Syst Rev: CD002840.
19. Ada L, Dean CM, Morris ME, Simpson JM, Katrak P (2010) Randomized trial of treadmill walking with body weight support to establish walking in subacute stroke: the MOBILISE trial. Stroke 41: 1237–1242.
20. Pohl M, Werner C, Holzgraefe M, Kroczek G, Mehrholz J et al. (2007) Repetitive locomotor training and physiotherapy improve walking and basic activities of daily living after stroke: a single-blind, randomized multicentre trial. Clin Rehabil 21: 17–27.
21. Richards CL, Malouin F, Dean C (1999) Gait in stroke: assessment and rehabilitation. Clin Geriatr Med 15: 833–855.
22. Hidler J, Nichols D, Pelliccio M, Brady K (2005) Advances in the understanding and treatments of stroke impairment using robotics devices. Top Stroke Rehabil 12: 22–35.
23. Krebs HI, Hogan N, Aisen ML, Volpe BT (1998) Robot-aided neurorehabilitation. IEEE Trans Rehabil Eng 6: 75–87.
24. Lo AC, Guarino PD, Richards LG, Haselkorn JK, Wittenberg GF et al. (2010) Robot-assisted therapy for long-term upper-limb impairment after stroke. N Engl J Med 362: 1772–1783.

25. Hidler J, Nichols D, Pelliccio M, Brady K, Campbell DD et al. (2009) Multicenter randomized clinical trial evaluating the effectiveness of the Lokomat in subacute stroke. Neurorehabil Neural Repair 23: 5–13.

26. European Stroke Organization (ESO) Executive Committee (2008) ESO Writing Committee. Guidelines for management of ischaemic stroke and transient ischaemic attack. Cerebrovasc Dis. 25: 457–507.

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