Stroke rehabilitation has been energized by the increasing confluence of supporting literature from animal studies, neuroimaging investigation of poststroke recovery, and an explosion of clinical rehabilitation trials. As basic scientists and clinical researchers converge, the exciting new technologies and more rigorous clinical methodologies used provide increasing support for some of the basic underpinnings of stroke rehabilitation (ie, the earlier rehabilitation is started the better the recovery), that greater intensity of treatment translates into greater recovery, and that improvement can continue for some time after discharge from hospital or rehabilitation center.

Early Therapy

Schallert et al noted that the brain appears to be primed to “recover” early after stroke. Biernaskie et al used a randomized controlled trial (RCT) in rats to examine the role of delay of therapy on rehabilitation outcomes. A small focal ischemic lesion was induced, and rats were then subjected to social housing (the control) or enriched rehabilitative training for 5 weeks beginning at 5, 14, and 30 days after stroke. Animals with enriched rehabilitative training at day 5 demonstrated a marked improvement in recovery, whereas those animals exposed at day 30 showed insignificant improvements compared with controls. Those in enriched rehabilitation at day 14 achieved an intermediate level of recovery compared with those that received enriched rehabilitation at day 5 and day 30. Rehabilitation at day 5 in rats was associated with an increased complexity of dendritic branching in the undamaged area when compared with those rehabilitated at day 30 or those exposed to social housing only, providing a biological explanation for greater recovery with earlier rehabilitation. The authors noted that their work confirmed previous primate research that demonstrated a time-dependent, rehabilitation-induced map reorganization after ischemic injury, with the remaining preserved cortical tissue being most responsive to rehabilitation training in the early compared with later phases of stroke recovery.

Neuroimaging evidence suggests that different parts of the brain may be involved at different times in recovery, and this pattern may vary according to the level of recovery. Ward et al undertook functional MRI studies in stroke patients while performing outcome-related motor tasks during the early (10 to 14 days) and late (>3 months) phases of recovery. A negative linear relationship was seen between task performance and activation in the primary and nonprimary motor areas at both time points, which suggested that recruitment occurs more widely within motor-related regions in the early and the late poststroke phase in patients with poor recovery. In contrast, other areas of the brain (contralesional middle intraparietal sulcus, contralesional cerebellum, and ipsilesional rostral premotor cortex) were recruited only in the early and not in the late phase in patients with poor outcomes. The authors concluded that time-dependent differences in activation patterns associated with recovery were significant and suggested that different therapeutic approaches may be required at different stages to gain most from rehabilitation.

These studies emphasize the importance of early rehabilitation for good outcomes. Although supported by a number of nonrandomized comparative trials, a recent randomized controlled study showed that intensive rehabilitative treatment given in 2 60-minute sessions for 14 days after stroke onset did not improve functional outcomes in acute ischemic stroke patients. In contrast, Feys et al, using a randomized controlled design, showed that adding an early, repetitive, and targeted stimulation to the arm during the acute phase after a stroke resulted in a clinically meaningful and long-lasting effect on motor function in patients, even after 5 years. Additional RCTs may well be unethical in light of recent mechanistic studies, which strongly support the concept that delays in accessing rehabilitation for appropriate stroke patients have a negative impact on recovery.

The emphasis on early rehabilitation should not preclude appropriate rehabilitation in chronic stroke patients. Modulation of motor networks may still be possible in chronic stroke patients. In a small but well-conducted study, Luft et al found that bilateral arm training with rhythmic auditory cueing induced reorganization in contralesional motor networks in patients recruited 3 to 6 years after stroke, suggesting that the brain retained the capacity to recover well beyond the acute injury phase.
Intensity and Frequency of Treatment
The evidence that greater intensity and frequency of therapy improves functional outcomes continued to grow in 2004. Kwakkel et al.\(^8\) conducted a meta-analysis of the effects of augmented exercise therapy after stroke and found that such treatment had a small but favorable effect on activities of daily living (ADL) within the first 6 months after stroke. Meinzer et al.\(^9\) found that intensive language training significantly improved language functioning and that this was correlated with cortical perilesional reorganization or plasticity. In an observational study, Bode et al.\(^10\) investigated the importance of therapy focus and intensity after controlling for stroke severity. They found that therapies accounted for a significant proportion of the variance in residual functional change and concluded that content and amount of therapy are important predictors of greater-than-expected gains in self-care and cognition. Sonoda et al.\(^11\) conducted a comparative study of stroke patients admitted to a conventional stroke rehabilitation program 5 days per week and patients admitted to a full-time integrated treatment (FIT) program 7 days per week. Both groups had similar functional independence measure (FIM) scores at admission; however, the FIT group had significantly shorter lengths of stay and were discharged with higher average FIM scores and nearly double the FIM efficiency scores.

Nevertheless, evidence shows that we are struggling to provide the intensity and frequency of therapy required to improve outcomes. Bernhardt et al.\(^12\) conducted an observational behavioral mapping study on 64 stroke patients in 5 acute stroke units. The authors reported that patients engaged in minimal therapeutic activity or moderate therapeutic activities for only 12.8% of the therapeutic day (8 AM to 5 PM). Patients were resting in bed 53% of the time and were alone for 60.4% of the time. Therapist contact constituted only 5.2% of the day. Previous studies have shown similar limited therapist–patient contact time in stroke units. Similarly, Lenz et al.\(^13\) have reported that poor participation in therapy was common during inpatient rehabilitation and resulted in lower improvements in FIM scores and longer lengths of stay even when controlling for admission FIM scores.

Because resources for stroke rehabilitation are limited, an answer may be the use of assistive technologies, in particular, robotic therapies. Reinkensmeyer et al.\(^14\) note that robotic therapy devices allow for precise control and measurement of therapy, allowing for research into the optimal training techniques and dosage of rehabilitation therapies. Robotics allow for some of the labor-intensive training tasks performed currently by therapists to be performed by automated devices, thereby providing patients with greater access to therapy. As the evidence grows that more intensive therapy influences recovery, robotics may offer an opportunity to meet an important treatment gap.

Outpatient Rehabilitation Therapies
There is a great deal of interest in therapies delivered at home after discharge from rehabilitation. Legg et al.\(^15\) identified 14 trials involving 1617 stroke patients. Therapy-based rehabilitation services for stroke patients living at home within 1 year of experiencing a stroke resulted in a significant improvement in the ability to manage ADL and reduced the likelihood of deterioration in ADL. McClellan and ADA.\(^16\) in an RCT of a simple 6-week home-based mobility program in stroke patients discharged from physiotherapy, found that treatment improved standing. Lin et al.\(^17\) found that even low-intensity home-based physical therapy is able to improve lower limb motor function in patients >1 year after stroke. This may be because the nature of stroke motor therapy itself can be altered at home to be more task specific while remaining within the typical contact time parameters (ie, 30 to 45 minutes per session) and be as effective as traditional motor approaches in rehabilitation facilities.\(^18\)

In a study by Lincoln et al.,\(^19\) 428 stroke patients and their caregivers were randomized to rehabilitation from a community stroke team or to routine care, which could include day hospitals or outpatient departments. There were no significant differences between patients who received rehabilitation from community stroke teams and those who received routine care in their independence in ADL, mood, quality of life, or knowledge of stroke. Patients in the community stroke team group were more satisfied with the emotional support they received. Caregivers of patients in the community stroke team group were under less strain and reported greater levels of overall satisfaction.

Supporting and training caregivers in the caregiving role is emerging as an important aspect of stroke rehabilitation. In an RCT of 300 patients and their caregivers, Kalra et al.\(^20\) showed that formal training of caregivers during patient rehabilitation was associated with less caregiving burden, better psychological outcomes, and higher quality of life in caregivers and improved psychological outcomes and quality of life in patients. Training caregivers also reduced overall costs of health and social care.

Neuroimaging in Stroke Recovery
The first International Workshop on Neuroimaging and Stroke Recovery was held in New York, NY, in February 2004.\(^21\) This produced an excellent state-of-the-art review, which we do not have space in this article to adequately summarize, that is recommended reading. The authors of the review note that there is growing evidence that the cortical responses to ischemic injury designed “to promote recovery of function” occur “both earlier and later than had been previously suspected.” The authors go on to point out that functional neuroimaging and neurophysiological techniques show “that the human brain has not only the capacity to activate alternative regions during recovery, but that the system is a dynamic one, subject to behavioral and pharmacological interventions that could potentiate recovery” and that clinicians and scientists have a responsibility to come together to study stroke recovery in a more rigorous manner.

References


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What's New in Stroke Rehabilitation: Back to Basics
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