Stroke Recovery and Rehabilitation

Robert Teasell, MD, FRCPC

One of the most exciting areas of stroke research is our increasing understanding of the brain's plasticity and the ability of rehabilitation to influence neurological recovery and subsequently impact clinical outcomes. Pomeroy and Tallis note, "The recent revolution in our understanding of the nervous system as being soft-wired, of the potential for recovery through reorganization and of the central role of afferent information is ground for optimism."

**Stroke Recovery**

Numerous theories and hypothesis have been forwarded to explain the neurological recovery seen after an acute stroke. Functional brain imaging has offered an opportunity to visualize cerebral activation associated with recovery from a stroke. Functional MRI, PET, and transcranial magnetic stimulation are now being used to demonstrate activation after stroke associated with specific stimuli or tasks.

Studies examining recovery of the affected upper extremity with rehabilitation therapies have shown distinct patterns of cortical reorganization. The predominate pattern, which correlates with therapy-related improvements in upper extremity movement, involves increases in fMRI activity in the premotor cortex and secondary somatosensory cortex contralateral to the affected arm and in the superior posterior regions of the cerebellum bilaterally. Stroke patients not only show this extended activation on the contralateral side, but unlike controls they also activate the ipsilateral motor cortex. Feydy et al were able to demonstrate that the nature of the lesion played a role in the development of cortical reorganization; involvement of the primary motor cortex resulted in increased ipsilateral activation, whereas sparing of the primary motor cortex resulted in increased contralateral sensorimotor cortex involvement. Cramer et al used fMRI to study unilateral stroke patients with chronic hemiplegia that spared regions of motor cortex. Activation in stroke-affected hemisphere was evaluated by stimuli/activities independent of the stroke-affected corticospinal tract. Stroke patients activated surviving cortical regions with similar frequency as controls, generally with a smaller activation volume. After a chronic hemiplegic stroke, surviving motor cortex demonstrated preserved activation for upper extremity sensorimotor functions.

Functional brain imaging has also been used in aphasic patients. Not unexpectedly, there is predominance of the left hemisphere over the right in language functions; however, language recovery depends on the restitution of the speech-relevant network that involves both hemispheres.

**Stroke Rehabilitation**

Stroke rehabilitation research has enjoyed a renaissance over the past decade. A recent review of the stroke rehabilitation literature discovered 270 randomized controlled trials looking specifically at issues that involved rehabilitation of stroke patients through 2001. What was most remarkable was the breathtaking and exponential pace at which randomized controlled trials (RCTs) in stroke rehabilitation are being undertaken; the results from almost 100 RCTs were published from 1997 to 2001 alone.

Pettersen et al found that after stroke rehabilitation, deterioration occurs as a consequence of concomitant chronic disabling disorders and recurrent strokes; otherwise, patients tend to remain within their own home with >80% still doing so at 3 years. The tools we have come to rely on, the FIM and Barthel Indices, may underestimate the impact of stroke; new tools like the Stroke Impact Scale, which measure quality of life, seem to be more inclusive, with the finding that "recovered" stroke still had a negative impact on a variety of functional activities.

There is now strong evidence when comparing RCTs that greater intensity of aphasia therapy results in improved outcomes as opposed to less intense therapy, where there seems to be little or no benefit. Cauraugh and Kim demonstrated the benefits of coupling different motor recovery treatments to improve motor outcomes after stroke. Pewrala et al found cutaneous stimulation combined with inpatient rehabilitation in the paretic upper extremity significantly improved motor performance and upper limb sensation. Along similar lines, Werner et al found treadmill training with partial body weight support accelerated restoration of gait ability in chronic nonambulatory stroke patients compared with treadmill training alone. Combining therapies, greater intensities of therapy, and increasing overall afferent input as mechanisms of improving after stroke recovery along with functional imaging studies demonstrate the brain’s plasticity and potential for recovery after stroke.

Early supported discharge, providing interdisciplinary rehabilitation in the home instead of in a hospital, seems to offer the same benefits as in-hospital stroke rehabilitation unit, but this concept has only been tested in a less severely disabled stroke patient population. A systematic review found
that such an approach could potentially save hospital beds, with a 15% reduction in overall mean costs in that subset. A recent Cochrane review reported that care pathways in stroke units actually resulted in significantly lower patient satisfaction and quality of life. The authors noted, “There is currently insufficient supporting evidence to justify routine implementation of care pathways for ... stroke rehabilitation.” This was confirmed by Hoenig et al, who found the structure of care (systemic organization, staffing expertise, and technological sophistication) was not associated with better functional outcomes, whereas compliance with AHCPR poststroke rehabilitation guidelines improved those same outcomes. This apparent paradox may signify the importance of using evidence or guidelines to assist rehabilitation clinicians in individualizing the rehab of stroke patients as opposed to a “one size fits all” approach.

It has long been known that improved social support improves outcomes, and although not studied yet in a formal RCT, the evidence that social support improves outcomes has been impressive. Grant et al in an RCT examining a social problem-solving telephone partnership intervention acquired better problem-solving skills, less depression, greater care-giver preparedness, and significant gains in social functioning and emotional health. The importance of social support in community reintegration continues to be an underestimated factor.

Despite the explosion of clinical stroke rehabilitation research, there remain many important unanswered questions. The next few years promise to be an exciting time in stroke rehabilitation research.

References

Keywords: magnetic resonance imaging; functional; recovery; rehabilitation; reorganization; stroke
Stroke Recovery and Rehabilitation
Robert Teasell

Stroke. 2003;34:365-366
doi: 10.1161/01.STR.0000054630.33395.E2
Stroke is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2003 American Heart Association, Inc. All rights reserved.
Print ISSN: 0039-2499. Online ISSN: 1524-4628

The online version of this article, along with updated information and services, is located on the
World Wide Web at:
http://stroke.ahajournals.org/content/34/2/365

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published
in Stroke can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office.
Once the online version of the published article for which permission is being requested is located, click
Request Permissions in the middle column of the Web page under Services. Further information about this
process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to Stroke is online at:
http://stroke.ahajournals.org//subscriptions/