Stroke Rehabilitation: New Strategies for Recovery

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U.S. Stroke Facts

- 30% initial mortality
- 600,000 stroke survivors/yr
  - 10-15% chance of new stroke in 1 year
  - ~30% chance of having new stroke in 3 years
- At 6 months
  - 50% - doing well
  - 40% - significantly disabled
  - 10% - institutionalized

U.S. Stroke Facts

- Stroke is 3rd leading cause of death and leading cause of disability
- 730,000 new strokes/year
- A new stroke occurs every minute
- 4 million stroke survivors

Secondary Stroke Prevention American Stroke Association

- Hypertension (after acute period)
  - Absolute level uncertain; at minimum – benefits with reduction of 10/5
  - Target 120/80
  - Lifestyle changes or combination of diuretic and ACE inhibitor
- Diabetes mellitus
  - Near normoglycemic levels; Hgb A1c < 7.0
- Platelet inhibitors for ischemic strokes
  - Aspirin, clopidogrel, or aspirin/dipyridamole are acceptable
- Anticoagulation
  - A. fibrillation; prosthetic heart valves; dilated cardiomyopathy; or post MI with clot x 3 mos)

Sacco et al., Stroke 2006
Secondary Stroke Prevention
American Stroke Association

► Carotid endarterectomy for recent stroke
  - > 70% stenosis – if surgical morbidity/mortality is < 6%
  - 50-69% stenosis – patient specific
  - Surgery should be done within 2 weeks, not delayed
  - Stenting not inferior in specific cases (hi-risk, re-stenosis, etc.)

► Hyperlipidemia
  - Lifestyle, diet and statin agents are recommended
  - Target goal with CHD or symptomatic atherosclerotic disease is LDL-C of <100 mg/dL and LDL-C of <70 mg/dL for very-high-risk persons with multiple risk factors
  - Statin also recommended even if no increased cholesterol or atherosclerosis

► Lifestyle modification
  - Exercise; no tobacco or excess alcohol; weight reduction if obese

Sacco et al., Stroke 2006

Disability after Stroke

<table>
<thead>
<tr>
<th>Type of Disability</th>
<th>Acute - %</th>
<th>6 mos. - %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobility</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Help with transfers - bed to chair</td>
<td>70</td>
<td>19</td>
</tr>
<tr>
<td>Unable to walk independently</td>
<td>73</td>
<td>15</td>
</tr>
<tr>
<td>Communication</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marked communication problems</td>
<td>52</td>
<td>15</td>
</tr>
<tr>
<td>Activities of Daily Living (ADL)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Needs help with grooming</td>
<td>56</td>
<td>13</td>
</tr>
<tr>
<td>Needs help with toileting</td>
<td>68</td>
<td>20</td>
</tr>
<tr>
<td>Needs help with feeding</td>
<td>68</td>
<td>33</td>
</tr>
<tr>
<td>Needs help with dressing</td>
<td>79</td>
<td>31</td>
</tr>
<tr>
<td>Needs help with bathing</td>
<td>86</td>
<td>49</td>
</tr>
</tbody>
</table>

Wade, 1994

Time to Max Neurological Recovery

Jørgensen et al, Arch Phys Med Rehab, 1995

Time to Max Neuro and ADL Recovery

Jørgensen et al, Arch Phys Med Rehab, 1995
Rehabilitation for Stroke

Why do it?

Meta-analysis of 10 trials
1586 patients randomized to receive multidisciplinary team rehab vs. general medical care
28% reduction in mortality at 4 months
21% reduction in mortality at 1 year
Not related to “acute treatments”

Stroke Rehab – Why do it?

Where should it be done?

Comprehensive Stroke Units

Combination of acute care and rehabilitation
- Dedicated and interested staff - prevent secondary complications
- Early and substantial family involvement - enriches the environment
- Single most important “rehab” factor - early mobilization?

“...stroke patients who receive inpatient care in a stroke unit are more likely to be alive, independent, and living at home one year after the stroke. The benefits are most apparent in units based in a discrete ward.”

Cochrane Library (Evidence-Based Medicine)
Rehabilitation for Stroke

- Why do it?
- Where is it done?
- How is it done?

Stroke Rehabilitation – Multidisciplinary Rehab Team

- MD - leads team; addresses medical issues
- RN “integrator” - skin care; bowel and bladder function; patient and family education
- Physical Therapist – mobility and therapeutic exercise
- Occupational Therapist – activities of daily living (ADLs) and functional transfers
- Speech Pathologist - language, cognitive-perceptual training and dysphagia management
- Social Worker - psychosocial issues, case management

Stroke Rehab - How?

- Perform baseline assessment on admission
- Develop explicit rehabilitation goals and plan
- Actively involve the patient and family
- Provide remedial treatment for sensorimotor deficits
- Provide compensatory training for disabilities
- Identify and treat cognitive-perceptual deficits
- Identify depression and provide treatment
- Identify and treat speech and language disorders
- Educate the patient, family and caregivers
- Monitor progress; continue services

Post-Stroke Depression

- Escitalopram and Problem-Solving Therapy for Prevention of Poststroke Depression: A Randomized Controlled Trial
  Robinson et al. JAMA 2008;299:2391-2400

- Depression after stroke is common – up to 40%
- Untreated depression during the post-stroke period is associated with worse rehabilitation outcomes
- Treatment of depression and possibly preventive treatment for depression after stroke is feasible and effective
- Agents to be used include SSRIs and/or psychotherapy
Rehabilitation for Stroke

- Why do it?
- Who receives it?
- How is it done?
- Why does it work?

Why Does It Work?

- Is it the type of training?
  - PT/OT treatments vary among patients and rehab units.
- Is it the amount of training?
  - Patients spend ~5% of time in therapy in "intensive inpatient rehab".
- Is it a combination of factors?
  - "enriched environment"
  - exercise
  - training

Mechanisms of Recovery after Stroke

- Removal of edema and necrotic tissue
- Restore vascular supply
- Resolution of diascisis

Early Recovery

Diaschisis

Deactivation of brain regions remote from but connected to the area injured by stroke
- crossed cerebellar diascisis
  - "spinal shock"

PET scan – R middle cerebral artery infarct
**Mechanisms of Recovery after Stroke**

- Early Recovery:
  - Removal of edema and necrotic tissue
  - Restore vascular supply
  - Resolution of diaschisis

- Late Recovery:
  - Unmasking of inhibited pathways
  - Reinforcing parallel pathways
  - Sprouting and remodeling of neurons

**Regions for Motor Recovery**

- If primary motor cortex is damaged -
  - *Ipsi*-lesional primary motor cortex
  - Premotor cortex
  - Supplementary motor area
  - are prime sites for neuroplasticity

**Neural Effects of Rehabilitation Training**

**METHOD**
- Trained monkeys to reach food pellets
- Microelectrode mapping of hand/arm motor cortex
- Created an ischemic infarct of hand/arm motor cortex
- Gave some animals “physical therapy” (assisted reaching for food)
- Remapped hand/arm motor cortex

*Nudo et al, Science, 1996*
Neuroplasticity and Clinical Neurorehabilitation

“Proof of principle studies” show multiple ways to enhance post-stroke motor performance
- Change sensory input to the stroke hemisphere or unaffected hemisphere
- Change inter-hemispheric interactions
- Apply electrical or magnetic stimulation to stimulate or inhibit affected or unaffected hemispheres

Selected Strategies to Enhance Motor Recovery

1. Change sensory input from either hand improves function on “weak” side
2. Reducing sensory input from “weak” upper arm improves “weak” hand
3. Electrical (tDCS) or magnetic stimulation (rTMS)
   - Stimulate peri-lesional region enhances training
   - Inhibit motor cortex in unaffected hemisphere

New Rehabilitation Strategies Post-Stroke

- Constraint-induced motor therapy
- Body weight-supported treadmill training
- Robotics

Clinical Application - Constraint-Induced Motor Therapy

Background:
- Monkeys with brain lesions or de-afferented limbs will not use them - theory of “learned non-use” (Taub)
- If the unaffected limb is “constrained”, movement in the impaired limb is partially restored
- Treatment - “constraint-induced therapy” - overcomes “learned non-use”
Constraint-Induced Motor Therapy

► **Subjects:**
  - 9 stroke patients; >1 year after a stroke
  - Hemiparetic with some use of arm; 20° wrist and 10° finger extension

► **Method:**
  - 4 subjects “forced” to use weak arm, 6 hours/day x 10 days in rehab; good arm restrained 90% of waking hours for 2 weeks
  - Control group “lots of attention” + passive movement

► **Outcome:** Functional use of arm

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EXCITE Trial
(Wolf et al, JAMA 2006)

► 222 patients - 3 to 9 months post-stroke
► Less affected arm placed in a safety mitt for 90% of waking hours x 2 weeks
► Behavioral training (6 hours/day) on pre-selected tasks (e.g. wrapping a present; writing; etc)
  - “chunked”; repetitive trials with frequent feedback
► Controls – received “usual care”
► Primary outcomes – Function at 1 year
  - Real world arm use – Motor Activity Log
  - Laboratory arm use – Wolf Motor Function Test

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Lower Function – 10° wrist ext; 10° thumb abduction; 10° extension 2 f ingers
Higher Function - 20° wrist ext; 10° finger ext at MCP and IPs
Constraint-Induced Motor Therapy (CIMT)

Clinical Application – Body Weight-Supported Treadmill Training

- Derives from work in spinalized cats
- Applied clinically in 1980s
- Individuals walk on treadmill with gradual reduction in body weight support
- Optimal training parameters – speed; duration of training; level of disability – are uncertain

Functional MRI - Pre- and Post-Constraint Induced Motor Therapy (CIMT)

Body Weight-Supported Treadmill Training

Kim et al, Yonsei Med J, 2004
**Body Weight-Supported Treadmill Training**

- 7 non-ambulatory stroke patients – minimum of 3 months after stroke
- A-B-A design - 3 weeks (15 sessions)
  - A = Body weight-supported treadmill training
  - B = Standard Bobath physical therapy
- Outcomes – gait measures, motor function, spasticity

Hesse et al, Stroke 1995

**Functional Ambulatory Categories**

- 0 - No walking or assist of 2+ persons
- 1 - Firm continuous assist of 1 person
- 2 - Continuous or intermittent assist of 1 person
- 3 - Supervision of 1 person without assist
- 4 - Walk independently on level ground
- 5 - Walk independently on any surface
Body Weight-Supported Treadmill Training

- May improve walking in functional ambulation in individuals who are unlikely to recover – evidence is still be developed
- Mechanism may be reinforcement of neural programs for gait
- Provides a form of task-specific training along with exercise.
- Long-term benefits are not known (LEAPS trial)

Stroke Rehabilitation

- Secondary stroke prevention
- Organized stroke care is best
- Use emerging science to influence brain plasticity
- Outcomes are not always excellent, but good rehab management can maximize recovery

Brain Aerobics