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Recent Advances in Stroke Rehabilitation--2006

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Mechanisms of Recovery from Stroke

- Resolution of the ischemic penumbra
- Resolution of edema
- Resolution of diaschisis
- activity through partially spared pathways
- Use of ipsilateral pathways

Dombovy and Aggarwal, 2000

Mechanisms of Recovery from Stroke

- Recruitment of parallel systems and use of distributed networks
- Cortical and subcortical reorganization, morphologic plasticity
- Pharmacologic/neurotransmitter plasticity
- Alternate behavioral strategies (develop compensatory strategies)

Dombovy and Aggarwal, 2000

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Rehabilitation: passive therapies: no volitional movement need occur

- Passive ROM / positioning
- Exercise equipment that moves extremities
- Movement with total assistanc extensive bracing
  - Bed mobility
  - Sitting and Standing
  - Transfers (e.g., from bed to chai
  - Ambulation

Rehabilitation: active therapies: encouraged / forced volitional limb use

- Active / resistive ROM
- Mobility training requiring less than total assist
- Volitional self care training
- Speech therapy: patient actively speaks or performs language task
- Constraint Induced Movement Therapy (CIMT)
- Partial Body Weight Supported Treadmill

Benefits of Passive Therapies

- Improved proprioception
- Improved toleration of upright position (improved autonomic responses)
- Limited improvement in strength (possibly none)—related to reflex muscle contractions
- Improved alertness from being upright
- Note: there is very little, if any reduction in learned non-use.

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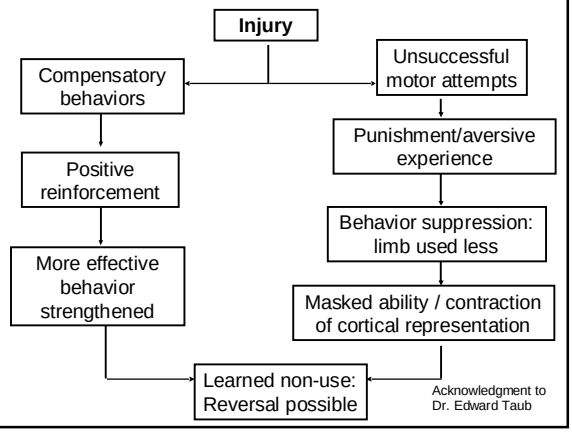
Benefits of Active Therapies

- Improved proprioception
- Improvement in strength / conditioning
- Improved efficiency of voluntary motor recruitment of trained muscles
- Reduced or reversed learned non-use

Constraint-Induced Movement Therapy (CIMT)

- Forced-use of the affected body part
  - most studied in hemiparetic upper extremity
- Paradigm for extremely active therapy
- Target of Treatment
  - Patient completes standard rehabilitation and has significant motor return in a limb but does not use limb.
  - How can further recovery of function occur?



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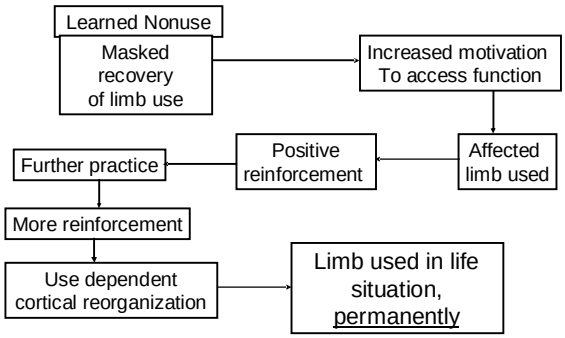
Overcoming Learned Nonuse

Acknowledgment to Dr. Edward Taub



CIMT for upper extremity: University of Alabama protocol

- Inclusionary Motor Criteria
  - 20 degrees extension of wrist
  - 10 degrees extension of each finger
- Taub's estimate: 20-25% of stroke survivors fulfill that criteria
  - Reality: only 5% (Grotta, et. al. 2004)
- Therapy is given 6-7 hours per day, for 8-10 sessions over two weeks.

CIMT for upper extremity: Modifications of UAB Protocol

- 1.5-3 hours/day for 4-10 weeks
- Wearing of mit on less involved side 5 hours/day
- More severe hemiparesis: 10 degrees wrist extension and 10 degrees extension of two fingers.
- Acute or subacute time course

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Shaping

- CIMT is more effective with “shaping”
- Daily activity tasks are broken down into sub-tasks of gradually increasing difficulty
- Each subtask is mastered before advancing to the next subtask
- Therapist selects and limits tasks permitted with weak arm.

Status of CIMT

- Many small, variably controlled studies: show moderate-large effect on UE function and use
- Hakkennes & Keating, 2005: meta-analysis of 9 controlled trials: 8 of 9 showed significant effect sizes in favor of CIMT for at least one measure of UE function
- 2006: completion of EXCITE: multicenter USA study (patients < 12 mo post-CVA):

Evidence for Neural Plasticity in Humans

- Functional MRI
- Transcranial Magnetic Stimulation

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F-MRI Scans and intensive therapy

- Similar changes are noted in patients who receive sufficiently intensive treatment (5-6 hrs / day)
- Neuroplasticity changes also noted for task-specific training of lower intensity.

Evidence for Human Neural Plasticity: Transcranial Magnetic Stimulation

- In recovered patients: stimulability of motor area of side of infarction correlates with motor recovery (Bastings et al, 2002 and Koski, 2004)
  - Surface area
  - amplitude of evoked motor responses
- CIMT associated with enlargement of stimulable motor area governing paretic limb (Liepert J, et al, 2000)

CIMT: Extreme intensity of therapy: needed?

- Evidence of Neuroplasticity for less intensive regimens. (Page, 2003)
- Less intensive therapy (30-45 min 3-5x/wk) is more effective if task specific.
- 4 positive RCT's of speech therapy had an average of 4 times the intensity of 4 negative trials (Bhogal, et al, 2003)
- MossRehab Aphasia Center: task specific speech therapy can lead to gains months or years after stroke

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Partial body weight supported gait in hemiplegia Kosac and Reding (2000)

- Up to 45 minute treatment / day, 5 days /wk
- Comparison to ambulation with assisted ambulation with bracing
- 56 patients of varied severity: no difference between groups
- 12 patients with severe hemispheric deficits: significant in ambulation (no support)

Partial body weight supported gait training

- Extremely therapist-intensive for severely hemiparetic patients
- Even higher functioning patients need close monitoring
- Taxing to severely weak patients: will tolerate only a few minutes to start
- VO_2 and heart rate < no support
- >30% support nonphysiological patterns of muscle contraction—probably not

Partial body weight supported treadmill training

- Cochrane meta-analysis: trend for benefit only for patients already independent.
- One controlled study of 100 patients showed significant gains in speed and endurance (over ground) and motor recovery c/w non body weight support. (Vistin, et al, 1998)
- Future: combine with cyclic FES to

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Functional Electrical Stimulation

- Usually single or dual channel
- Used as stimulation
  - Facilitation for regaining movement / strength
  - Reduces shoulder subluxation and pain
- Limited role for

Programmable or Patterned FES

- Multiple channels, programmed
- Can be designed to perform functional activities (but not U.S.FDA approved yet)
  - Even with plegic hand
- Upper extremity units being tested
- For hand /wrist unit: need proximal strength to use
- May or spasticity
- Spasticity may limit effectiveness

Bioness, Inc. (See Ring, 2005)

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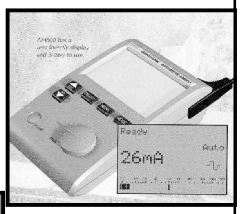
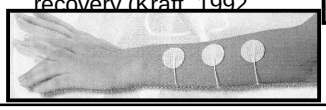
Cyclic: EMG Biofeedback device linked to FES

- When muscle starts to contract, FES device fires, providing stronger muscle contraction
- Documented in small studies to improve recovery (Kraft, 1992





Neuromove™

Cyclic (Implanted) Multichannel FES

Chae, et al, Am J PM&R, 2001

- Requires some volitional contraction
- Small studies: implanted electrodes (UE and LE)
- Improvement noted in limb strength and motor capability
- No increased improvement in ADL's / Gait
- Some improvement noted in spasticity
- Advantages: lower voltage, more definitive placement

Robotic therapy

- Robot can passively move extremity.
- Robot senses volitional contraction then reduces or increases force, permitting active movement.
- Patient plays linked video game, which reinforces active movement

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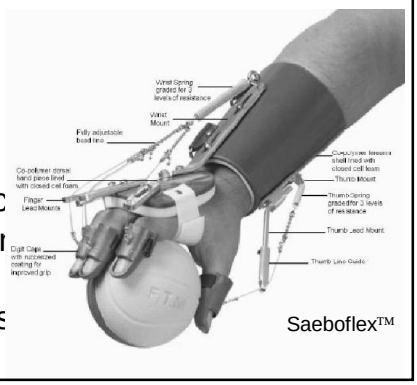
Dynamic Extension Assist Orthoses



Saeboflex™

Enhancing plasticity and recovery after stroke

- Intensive active sensory-motor therapies
- Task specific therapies
- Medications
  - That motivate active participation—antidepressants
  - That may affect neuro anatomic / physiologic changes
- Transcranial Magnetic Stimulation
- Implanted electrodes for electrical

Medications to Enhance Stroke Recovery

- Piracetam (nootropic)
- Noradrenergic (methylphenidate, amphetamine, modafinil)
  - Improves arousal, attention, concentration, initiation
- Dopaminergic (amantidine, L-Dopa/carbidopa, bromocriptine, pramipexole, others)
  - May be more helpful for trouble starting/stopping or changing tasks

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Therapeutic transcranial magnetic and electrical stimulation of cortex

- A train of repeated impulses is aimed at the motor cortex (or other target)
- Stimulation with different parameters may facilitate or inhibit (block) activity of areas stimulated.
- Contralateral stimulation (intact hemisphere) may inhibit recovery
- Neurosurgically implanted electrodes: in Phase I and II trials. (Northstar Neuroscience, Inc.): subthreshhold

Approach to Motor Rehabilitation: Upper extremity hemiparesis

- Plegic: PROM, Facilitation, Proprioceptive training, Passive or Patterned FES
- Severe: (Minimal recovery): All of above—and AAROM, Saeboflex, cyclic FES, Robotic therapy
- Moderate (At least limited isolated motion present): Proprioceptive training, AA-AROM, Saeboflex, cyclic FES, Robotic therapy, CIMT

Stroke Recovery: Role of Inpatient or Outpatient Rehab Unit

- To stimulate and motivate patients to participate in the rehab process—as actively as possible

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