Management of the hemiplegic upper limb

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Trunk Control

• Foundation of all head, neck, and limb movement
• Functionally
  – Reach beyond arm’s length
  – Interaction with environment
• Anticipates
• Perceptual influence
  (Gillen, 2011)

Alignment of the trunk

• Alignment/ Biomechanical Considerations
• Optimal alignment
  – Anterior pelvic tilt
  – Lumbar extension
  – Thoracic extension

Lower trunk stability

• Pelvic position
• Co-Contraction of Muscles
  – Ant abdominals & Lumbar Ext. → thoracic ext
  – Right & Left Lateral abdominals
    (Bohman, 2003)
• Dynamic
  – Changes in base of support
  – Leading with upper vs. lower trunk
    (Runyon, 2003)
Dynamic Dissociation

- Normal control requires the ability to dissociate (separate) different parts of the body from each other (Mohr, 1990)
  - Eccentric/Concentric muscle contraction
  - Ex: Upper trunk rotation with lower trunk stability while reaching for clothing during dressing
- Difficulty with dissociation
  - Soft tissue tightness
  - Bony contracture
  - Efforts by patient to decrease movement

Body Positioning

- Position of feet – EMG studies
  - Knee Flexion ➔ Increased muscle activity in trunk
  - Knee Extension ➔ Decreased muscle activity in trunk (Anderson & Ortengren, 1974)
  - When feet under knees, anterior pelvic tilt and trunk extension are enhanced
- Functional Influence
  - Jebsen Taylor Hand Function Test
    • Higher functional scores when patient sitting in neutral position vs. flexed or laterally flexed position (Gillen et al., 2007)

Influence on Facial and Oral Motor

- Vocalization
- Swallowing
- Manipulation of solid/liquid food
- Facial Expression
- Respiration (Runyon, 2003)

Trunk Malalignment vs. Alignment

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Effect of pelvis on upper extremity

- Posterior pelvic tilt $\rightarrow$ lumbar flexion $\rightarrow$ thoracic flexion $\rightarrow$ scapular abduction $\rightarrow$ humerus internal rotation
- Anterior pelvic tilt $\rightarrow$ lumbar extension $\rightarrow$ thoracic extension $\rightarrow$ scapular adduction $\rightarrow$ humerus external rotation

Stretch for Thoracic/ Lumbar Ext

- Wedge Stretch
  - Supine on large wedge
  - Two towel rolls in inverted “T” position
    - One in lumbar region
    - One along spine in thoracic region

Wedge stretch

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Dynamic Trunk Control and Trunk Strengthening Activity

Taping

- Kinesio Tape
  - Light flexible tape
  - Supports muscle
  - Removes congestion (edema)
  - Corrects joints
  - Activates analgesic system (pain relief)
  (Gillen, 2004)

- McConnell Tape /Leukotape
  - Very rigid, needs 2 layers of tape to protect skin
  - Stabilizes
  - Re-aligns
  - Reduce Pain
  (Gillen, 2004)

Taping for Postural Training

Video of Taping for Postural Training
Frequency and Duration of Taping

- Varied evidence of frequency and duration
- Anecdotal report
  - Duration of adhesive
  - Skin tolerance of tape/adhesive

Lab Time!!

- Anterior pelvic tilt
- Lumbar & Thoracic Extension
- Lower trunk facilitation
- Upper trunk facilitation

Anatomy/Biomechanics

- Joints/articulation
  - Glenohumeral
  - Scapulothoracic
  - Acromioclavicular
  - Sternoclavicular – only bony attachment of upper limb to the axial skeleton
- High mobility, Low articulation
  - Joint relies on muscle strength for stability
  - Post neurological event stability is lost with muscle decreased function
  - Reason why upper limb more affected than lower limb

Anatomy

- Key landmarks for the shoulder
  - Scapula: Acromian, root of the spine, inferior angle
  - Humerus: Humeral head
- Scapula has a concave/convex relationship with the rib cage
- Scapula is a curved surface that easily tilts and moves
Alignment/ Approximation

• Scapula
  – Acromian process is higher than the root of the spine
  – Inferior angle is against the rib cage
  – Sits in neutral plane of elev./ dep., abd./ add.

• Humerus
  – Humeral head approximated into the glenoid fossa
    (Runyon, 2003)

Alignment/ Approximation

• Therapist sitting lateral to patient
  – Front hand: Approximation of humeral head into glenoid fossa
  – Back hand: Approximation of scapula with inferior angle in forward direction
  – “Rotate the globe” (Runyon, 2003)

Scapular malalignment

• Occurs because of
  – Inactivity around scapula
  – Muscle imbalance around scapula
  – Trunk malalignment
    (Gillen, 2011)

Scapular malalignment

• Presents as
  – Subluxation
  – Abnormal scapular humeral rhythm
  – Pain and impingement
  – Ineffective movement patterns
  – Possible CRPS
  – Decreased function
    (Gillen, 2011)
Shoulder subluxation

- Palpable gap between the acromion and humeral head
- Subluxations occur within the acute hypotonic phase of hemiplegia
- Theory
  - Occurs due to prolonged downward pull by gravity on the arm against which hypotonic muscles offer little resistance (Chaco and Wolf 1971). Results in overstretching of the glenohumeral capsule (especially its superior aspect) and hypotonic supraspinatus and deltoid muscles (Basmajian and Bazant 1959, Shehani et al. 1981)
  - The combination of flaccid supportive musculature (in particular, the supraspinatus muscle) and a downward rotated scapula was presumed to predispose the head of the humerus to undergo inferior subluxation relative to the glenoid fossa (Basmajian and Bazant 1959 & Calliet 1980)

Biomechanics of Subluxation

- Not a result of positioning of downward scapular rotation
  - Prevost et al., 1987
  - Culham et al., 1995
  - Price et al., 2001
  - “Scapular position was not an important factor” and “unrelated” in the occurrence of inferior subluxation in hemiplegia (Prevost et al., 1987, & Price et al., 2001)
- Scapula does have influence because of alignment and biomechanical advantage in active ROM

Shoulder subluxation

- Subluxation is a result of weak rotator cuff muscles
  - Rotator cuff seats the head of the humerus into the glenoid fossa
- Remember Anatomy when considering tx methods
  - Rotator cuff (Internal muscle layer) and Deltoid (external muscle layer)
  - Focus on positioning and stability of scapula first

Subluxation Patterns

- Inferior
- Anterior
- Superior
  (Ryerson & Levit, 1998)
- Assessment of subluxation clinically
  - Palpation of subacromial space is most reliable form
  - Finger widths for measurement
    - (Hall et al, 1995 & Prevost et al., 1987)
Prevention of Pain & Complications

- Scapulohumeral Rhythm
- In a normal shoulder has 2:1 ratio
  - 2 parts humeral movement to 1 part scapular movement
  (Clarkson & Gilewich, 1989)

Abnormal scapulohumeral rhythm

- Scapulohumeral rhythm with hemiplegia
  - At most effected state neither portion actively moves
- With a non moving scapula & passively moving humerus
  - Subacromial trauma occurs at 90° shoulder flexion
  (Kumar, et al., 1990)

Subacromial Trauma

- DO NOT perform
  - over head arm raises
  - PROM greater than 90° shoulder flexion or abduction
  (Kumar et al., 1990)
- Will cause subacromial trauma
  - Impingement of supraspinatus under coricoacromial arch
  - Increased pressure on subdeltoid bursa
  - Impingement of brachial plexus
  - Impingement arterial and venous supply
  - Stretching of glenohumeral capsule
  (Griffin, 1968; Peat, 1968)

Superimposed Orthopedic Injuries

- Lesions of the rotator cuff
- Lesions of the biceps tendon
- Adhesive capsulitis
- Brachial plexus traction injury
- Impingement syndromes
  (Gillen, 2011)
Braus, Krauss, & Strobel, 1994

- Suggests that pain from SHS/ CRPS I is initiated by a peripheral lesion (tissue or nerve)
- Autopsy data
  - Confirmed micro-bleeding of the suprahumeral joint of the affected side
  - Subacromial trauma
- If cause is peripheral, than prevention program would be effective

Braus, et al., 1994

- Implemented Prevention Protocol:
  - Education to prevent peripheral injury
  - No PROM before scapula mobilization
  - No pain during exercise/ activity
  - No infusions into affected hands
- Incidence of pain from SHS decreased from 27% to 8%

Subacromial trauma is preventable!!

- Education is key
  - Patient, therapist, staff, family
    - https://patienteducation.osumc.edu/Documents/protect-shoulder.pdf
- Proper Handling
  - During ADL’s and transfers
  - Avoid inappropriate treatment choice
- Positioning
- Let Active ROM determine a patient’s Passive ROM limitation
- Safe PROM
  (Davies, 2000, Gillen, 2011)

Biomechanically safe PROM

- Completed by therapist or caregiver after training
  - Range scapula with approximation of scapular humeral joint
    (Runyon, 2003)
- Can be completed by patient
Range scapula with approximation of scapular humeral joint

• Elevation
  – Approximate scapula and humerus
  – Perform scapular elevation with inferior angle between therapist’s thenar and hypothenar eminence of hand
  – Have patient move into posterior pelvic tilt
    "Roll your belly back"
    "Hide your belly button"
    "Slouch and touch your chin to your chest"
    (Runyon, 2003)

Range scapula with approximation of scapular humeral joint

• Depression
  – Approximate scapula and humerus
  – Therapist places finger tips on patient’s spine of scapula
  – Have patient move head in lateral direction away from you. Ear on non-involved side to shoulder on non-involved side
    (Runyon, 2003)

Range scapula with approximation of scapular humeral joint

• Adduction
  – Approximate scapula and humerus
  – Therapist holds patient’s axillary area in web space
  – Perform adduction and maintain hold
  – Ask patient to slowly turn head in opposite direction
  – For additional stretch ask patient to place opposite hand on opposite hip with thumb pointing down
    (Runyon, 2003)

Range scapula with approximation of scapular humeral joint

• Abduction
  – Approximate scapula and humerus
  – Therapist places PIP’s onto patient’s medial border
  – Perform abduction and maintain
  – Ask patient to slowly turn head toward therapist and reach for therapist’s shoulder
    (Runyon, 2003)
Scapulothoracic Mobilization: Upward Rotation

- Patient lying on unaffected side
  - Approximate scapula and humerus and support upper limb
  - Therapist places fingertips on medial border by inferior angle
  - Perform upward rotation and maintain (Dale, 2005)

Clinical Use of Scapular Mobilization

- Assess current position of both scapulas
- Use only scapular stretches necessary to achieve approximation and symmetry of Hemiplegic side scapula with Non-Hemiplegic side scapula

Lab Time!!

- Anterior pelvic tilt
- Lumbar & Thoracic Extension
- Approximation
- Scapular mobilization
  - Elevation
  - Depression
  - Adduction
  - Abduction
  - Upward rotation
Biomechanically safe PROM completed by patient

• “Rock the baby” Cradle arm with trunk rotation to 60° shoulder abduction (Gillen, 2011)

Active Scapular Stability

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Biomechanically safe PROM completed by patient

• Lack of Glenohumeral joint external rotation is associated with pain
  – (Bohannon et al 1986, and Zorowitz et al, 1995)
• Stretch for external rotation
  – Lay supine with 45° shoulder abduction
  – Gently rotate to external rotation
  – Lay forearm on pillow for prolonged stretch (Gillen, 2011)

Gravity Eliminated AAROM

• Stability of scapula on thoracic wall with emphasis on upward rotation (Gillen, 2011)
• Improves shoulder function and subluxation

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Edema and Hemiplegia

- Increased venous congestion
- Decreased muscle activity
  - lack of muscle pump for venous return
  - Limited stimulation to superficial lymphatics
- Limbs in dependent position
- Poor positioning – obstruction of subclavical and pelvic area: lymphatic and venous flow

(Conosky, 2008, and Leibovitz et al., 2007)

Edema Measurement

- Measuring tape around joints
  - Inter-rater reliability
  - Very specific locations
- Volumetric Measurement
  - A change of 12mL or more is considered clinically significant

(Post et al, 2003)

Treatment for Edema Management

- Limited evidence
- Combination of mobilization and garments
  - Manual edema mobilization techniques
    - Manual lymph drainage, massage
  - Garments
    - Jobst ®, Isotoner ® gloves, Coban ®, Lymphadema wrapping
- Elevation alone can lead to guarding and disuse
  (Harden et al., 2006; Swan, 2004)
- Active motion in conjunction with elevation is more effective
  (Barreca, 2003)

Positional Elevation

- Gravity to assist hemodynamic flow in the limb backward and down toward heart
  - Assist to clear venous/ lymphatic congestion
- Contraindications
  - Heart failure – over stress the heart
  - DVT – transport clot to heart, lungs, brain
  - Arterial dysfunction – Raynaud’s phenomenon: decreased viability of distal end of limb (fingers and toes)
  (Burkhardt, 2004)
Positional Elevation

- Helps to mobilize fluid
- Edema returns when limb returns to dependent position
- Elevation of lower limb with 90° hip flexion not effective
  - Compression of vessels in pelvic region
    - Iliac artery/vein
    - Grouping of lymph nodes in pelvic region
  - Not above level of heart
    (Konosky, 2008)

Manual Massage

- Manual Lymphatic Massage
  - Superficial lymph nodes at neck, groin, and armpit are stimulated first
  - Light pressure: Superficial delicate structures
  - Massaged lightly with scooping technique
  - Proximal extremity first, the middle portion second, and distal portion last
    (Burkhardt, 2004)

Elevation and Manual Massage Combined

Manual Massage

AAROM with elevation

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Compression Garments

- Prevent backflow and limb refilling
  - Have to clear fluid first
- Temporary compression garments
  - Tubular support bandages
  - Isotoner Gloves
  - Self Adherent Wraps (ex. Coban)
- Compression Wrapping bandages
  - Requires training
  - Not Ace Bandage
  - Comprilan
    (Burkhardt, 2004)
Compression Gloves

- Contraindications
  - IV’s, fistulas, acute blood clot, severely impaired circulation, open wound
- Evaluation
  - Color of finger and nail bed 3-5 min. post donning
  - Compression at wrist
  - Does entire arm have swelling
  - Position during day
  - Skin integrity
  - Movement
  (Konosky, 2008)

Compression Gloves

- Off the shelf vs custom
  - Determined by shape and size of limb
- Provides 15-32 mmHg of pressure
- Seams on the outside
- Cost
- Long term vs short term
  (Konosky, 2008)

Intervention

Taping & Hemiplegic Shoulder

- Conflicting evidence that taping reduces pain
  - Ancliffe, 1992
  - Hanger et al, 2000
  - Griffin & Bernhardt, 2006
- Inner layer vs. outer layer
- “Moderate evidence that Strapping (taping) does not improve upper limb function or ROM” with a subluxation
  - Ebrsr.com, 2010
Taping and Hemiplegic Shoulder

• Postural retraining
• Approximation during **AROM**
  – Need to have muscle activity around joint you are taping to be affective
• Once taping is applied, complete scapular stability exercises and gravity eliminated AAROM exercises
  – Home Exercise Program & Therapy Sessions
Active Motion - Closed Chain AAROM with PVC pole

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Slings

- Debated in literature for at least 30 years
  - Variety of available slings
  - Controversy regarding effectiveness
  - When and how slings should be used
  - Possibly add to complications resulting from an extremity affected by stroke
    • (Gillen, 2011)
- Common goals by surveyed therapists
  - Decrease and prevent subluxation and pain
    • (Boyd & Gaylord, 1986)

Slings

- Hurd, 1974, Full arm sling:
  - No difference found in shoulder ROM, pain, or subluxation for pt’s with or without slings
- Zorowitz, 1995, Single-strap hemisling, Bobath roll, Cavalier support, Roylan humeral cuff sling:
  - “No absolute evidence that supports prevent or reduce long term shoulder subluxation” “or that a support will prevent complications of the shoulder subluxation”
- Dieruf, 2005, GivMohr Sling:
  - Reduces a subluxation when worn. No comment on long term effects, functional outcomes, ROM, or pain

Slings

- Ada et al, Cochrane Database Systematic Review, 2005
  - “There is insufficient evidence that to conclude whether slings and wheelchair attachments prevent subluxation, decrease pain, increase function or adversely increase contracture in the shoulder after stroke”
- Ebrsr.com, 2012
  - “There is limited evidence that shoulder slings influence clinical outcomes”
Slings and Subluxation – Cailliet, 1980

• If goal of sling is to provide glenohumeral joint stability, then the device must support the scapula on the rib cage in approximation to compensate for lack of support of the rotator cuff.
• Currently no slings on the market assist with realigning the scapula on the rib cage
• Therefore, slings cannot be prescribed to “reduce a subluxation”

Slings

Pros
• Protects from injury during transfers
• Allows therapist to control trunk and lower limbs during initial functional mobility
• May relieve pressure on brachial plexus and artery
• Supports weight of arm (Gillen, 2011)

Cons
• May contribute to neglect
• May contribute to learned nonuse
• May hold upper limb in a shortened position
• May initiate CRPS (Immobility, edema, pain)
• May predispose to pain due to shortened internal rotation
• Does not reduce subluxation
• Does not approximate scapula
• Prevents reciprocal arm swing
• Blocks sensory input
• Prevents balance reaction of upper limb
• May block spontaneous use

Slings

• Minimize use!!
• Immediate removal
• Pt. becomes dependent
• Avoid slings that position G-H joint in Internal Rotation
• Investigate alternate means of support
  – Lap trays, positioning in bed (Gillen, 2011)

Prevention of Secondary Impairment of Immobility: Resting hand splint

• Splinting has not been shown to effectively reduce spasticity, prevent contracture formation, or be effective to help improve active function following stroke.
  – Lannin et al. (2003)
  – Harvey et al. (2006)
  – Lannin et al. (2007)
  – Basaran et al. (2012)
**Prevention of Secondary Impairment of Immobility: Resting hand splint**

- “Despite numerous studies, two Level I systematic reviews reported that there is insufficient evidence to support the use of resting hand splints as a routine intervention in stroke rehabilitation” (Lannin & Hebert, 2003; Ma & Trombly, 2002)
- **EBRSR 2013**
  - There is strong (Level 1a) evidence that hand splinting does not improve impairment or reduce disability.

**Neurofacilitation Techniques**

- **Brunnstrom’s Movement Theory**
  - Limited Evidence
  - Wagennar et al. (1990) (n=7): “Time series analysis indicated that for one patient only, walking speed progressed more during the Brunnstrom phases than the NDT phases”
  - Last update 1992 by Sawner & LaVigne: Studies (25) cited to support the approach were published between 1898-1960

**Neurofacilitation Techniques**

- **Proprioceptive Neuromuscular Facilitation**
  - Kraft et al, 1992
    - NMES vs. PNF
    - NMES over PNF
- **Rood**
  - No Evidence

**Neurofacilitation Techniques**

- **NDT/Bobath**
  - Paci (2003): Systematic review of 15 papers concluding “Results show no evidence providing the effectiveness of neurodevelopmental treatment or supporting neurodevelopmental treatment as the optimal type of treatment, but neither do methodological limitations allow for conclusions of non-efficacy”
Neurofacilitation Techniques

- NDT/Bobath
- Luke et al. (2004): Systematic review of 8 trials to determine the effectiveness of the Bobath concept at reducing upper limb impairments, activity limitations and participation restrictions after stroke
- “Comparisons of the Bobath concept with other approaches do not demonstrate superiority of one approach over the other at improving upper limb impairment, activity or participation”

Neurofacilitation Techniques

- NDT/Bobath
- Kollen et al. (2009)
  - Based on predetermined criteria 16 studies involving 813 patients with stroke were included for further analysis
  - There was no evidence of superiority of Bobath on sensorimotor control of upper and lower limb, dexterity, mobility, activities of daily living, health-related quality of life, and cost-effectiveness
  - This systematic review confirms that overall the Bobath Concept is not superior to other approaches

Neurofacilitation Techniques

- NDT/Bobath
  - “The evidence overwhelmingly points to the lack of effectiveness of the Bobath approach when compared with a task-oriented approach”

Neurofacilitation Techniques

- NDT/Bobath
  - N=324: prospective multi-center (12) non-randomized parallel study
  - NDT vs. conventional treatment
    - Monitored via intervention checks including nursing
    - NDT group received more OT/PT
Neurofacilitation Techniques

• Conclusion
  – “The NDT approach was not effective in the care of stroke patients in the hospital setting. Health care professionals need to reconsider the use of the approach”
  – “Previous studies have already focused on several other outcomes measures such as walking ability, motor performance, muscle strength, upper extremity function, and depression but these were also unaffected but the NDT approach”
  – “Recovery after stroke may best be stimulated by the patient practicing motor tasks under similar conditions of strength, speed, and accuracy as in real life, and with similar cognition demands”

Neurofacilitation Techniques

• Proprioceptive Neuromuscular Facilitation, Rood, and Brunnstrom Approach
  – Evidence “sparse and inconclusive” (Sabari, 2010)
  – Based on outdated views of motor recovery and motor control (Ma & Trombly, 2002; Pollock, Baer, Pomeroy, & Langhorne, 2007; Steultjens et al., 2003)
• Neurodevelopment Treatment
  – No evidence of significantly better outcomes for NDT when compared with other treatments to improve upper limb motor function (Luke, Dodd, & Brock, 2004; Paci, 2003)

Shift in Rehabilitation Approach

• Self Examination
• Intervention supported by Evidence and Research
• Paradigm shift from traditional theories to Neuroplasticity

Neuroplasticity – What is it?

• Neuroplasticity → Changing the brain
• Capability of CNS to alter function and structure in response to use and motor learning
• Reorganization of undamaged systems in the brain
• The brain responds to functional/environmental demands
Neuroplasticity

• Borders of neuro mapping are not defined
  – Brain is moldable according to the will and actions of the individual
• Nudo (2001)
  – Adaptive plasticity in motor cortex
  – Functional and structural dynamic nature of the cerebral cortex

• Possible Explanations
  – Areas of the brain assume functions that were once the responsibility of a damaged area of the brain
  – Areas of the brain lay dormant until needed to assume functioning for damaged regions
  – Creating new pathways for the connections between neurons
    (Gutman, 2008)

Repetitive Practice

• High Intensity/ High Repetition → Cortical Changes
• Motivational Strategies for Patient
  – Self control vs. External Control
• Patient education
  – Importance of intensity of repetition
  – Intensive HEP

Learned Non- Use

• Decrease is muscle/ motor activity → decrease in function → frustration → avoidance of activity
• What happens cortically?
• Kleim (1998)
  – Motor cortex representation diminishes with immobilization beyond nine days
Neuroplasticity is Skill/ Activity Dependent

- Nudo, 2001
  - Plasticity is limited to behavioral experiences
- Nudo, 2003
  - Plasticity of the motor cortex are skill-dependent rather than simply use dependent.
- Cauragh, 2005
  - Upper extremity gains evolve from motor experiences and activity-dependent interventions

Chronic Recovery

- Thickbroom, 2004
  - Purpose: Investigate the relationship between changes in motor cortex organization and degree of motor function after stroke
  - Subjects: 27 pt’s with upper limb motor deficits up to 23 yrs after onset
  - Intervention: The hand’s corticomotor area was mapped with transcranial magnetic stimulation. Motor Assessment Scale and grip strength measurement were used as functional assessments. Task oriented treatment was provided

Thickbroom (Clin Neurophysiol 2004)

- Results: After treatment, motor maps of the hand showed displacement in 17 pt’s. Ten pt’s showed normalization of corticospinal conduction and a positive correlation between the magnitude of the map shift and grip strength in the affected hand.
- Conclusion: The present findings provide evidence that cortical plasticity and reorganization occurring after a stroke is functionally significant.

Neuroplasticity

- Active repetitive task oriented motion
Methods of Neuroplasticity
• Task Based Practice
• Mental Practice
• NMES
• Constraint Induced Movement Therapy

Task Oriented Approach
• Based on systems model of motor control and theories of motor learning
• Therapist is a teacher of motor skills
  – Select contextually appropriate functional tasks
  – Vary tasks to increase transfer of learning
  – Structure the environment the conditions of the task are present
  – Provide feedback
(Carr and Shepherd, 2003, and Gentile, 2000)

Positive Effects of Task Oriented Approach on Impairment level and Function
• Barker et al., 2008
• Blennerhasset et al., 2004
• Caraugh et al., 2006
• Michaelson et al., 2006
• Nelles et al., 2001
• Stinear et al., 2008
• Theilmann et al., 2004
• Weinstein et al, 2004

Task Oriented Approach
• Hubbard et al, 2009, Systematic Review
  – “We recommend that task-specific training be routinely applied by occupational therapists as a component of their neuromotor interventions, particularly in management related to post-stroke upper limb recovery”
Task Based Practice Opportunities

- Improved function of hemiplegic upper limb when using functional objects and activities vs. performing similar movement sequences in the absence of task performance
  - (Wu, Trombly, Lin, and Tickle-Degnen, 1998; Trombly and Wu, 1999; Wu, Trombly, Lin, and Tickle-Degnen, 2000; Fasoli, Trombly, Tickle-Degnen, and Verfaellie, 2002; Smedley et al., 1986; Winstein et al., 2004)
- Client’s are not making connection between non-functional activities and functional outcomes

Occupational Therapist Determines

- Each client’s current potential to relearn motor and cognitive skills
- How to match task-based challenges to each person’s current potential
- How to modify each person’s environment to provide the appropriate balance between challenge and compensation
  - (Sabari, 2011)

Real Life Challenges

- Busy caseload
- Productivity standards
- Limited time
- Challenging patients and family members
- Non-productive time: Documentation, meetings, in-services, etc.

Occupation Kits

- Treatment kits made prior to treatment session
- Lower Level – Gross Grasp
  - Placing eating utensils in organizer
  - Placing magazines in organizer
  - Table setting for 8
  - Removing dishes from drying rack
  - Placing tools in tool box
  - Placing CD’s in rack
  - Placing cooking utensils in tall container
  - Placing folded socks in bin/ drawer
  - Placing cans/jars on shelving
**Occupation Kits Higher Level – Bilateral coordination and fine motor coordination**

- Folding clothes in laundry basket
- Hanging clothes on retractable clothes line
- Packing a suitcase with clothes
- Putting batteries in remote control
- Putting toilet paper on holder and pull off a sheet
- Installing toilet paper holder on base
- Sanding plywood
- Installing a door knob
- Installing a smoke alarm

- Sorting and assembling assorted sized nuts and bolts
- Separating and placing play money in wallet
- Coins in coin bank or change purse
- Medication into pill organizer
- Wrapping a gift/package
- Stuffing envelopes
- Sorting paper clips
- Cutting and stapling paper
- Sorting coupons
- Scrap booking

**Mental Practice - Imagery**

- Rehearsing task or series of tasks mentally – Cognitive Rehearsal
- No physical activity
- Athletes – Sports psychology
- Supplement conventional therapy
- Used at any stage in recovery

(Back et al., 2006, & Jackson et al., 2001)

**Mental Practice**

- Activates the musculature in the same pattern that correlates with imagined movements – measurable on EMG
- Activates the cortical representation in the same pattern that correlates with imagined movements – measurable on fMRI
- Improves learning & performance
- Reorganizes motor cortex - Neuroplasticity

**Mental Practice**

- Most plausible mechanism to explain
  - “Stored motor plans for executing movements can be accessed and reinforced during mental practice”

(Page, 2001)
Mental Practice – How is it done?

- Audio recording
  1. Period of deep relaxation (3-5 min.)
  2. Mental Practice Portion
     - Involve every aspect of the experience including size of room, and full description of the movement including the feel of the movement.
     - "Imaging you are sitting in your favorite chair. The room is quiet. There is a table in front of the chair" "imagine there is a cup on that table with fresh apple juice in it. Feel yourself reaching for the cup. Feel the weight of your arm as you reach out. Feel your elbow straightening and your wrist extending. Your hand opens, and your fingertips touch the cool china cup" etc.
  3. Practice in the real world. Three listening sessions to one practice session
     (Levine, 2009)


- Method
  - Tape recorded guided imagery + traditional therapy vs. traditional therapy
  - Mentally perform series of tasks
    - Ex: reach for cup
  - 10 min – 1 hr/ day, 3-5 sessions/ week, 3-6 weeks
- Results
  - Significant improvement in Fugl-Meyer and Action Research Arm Test Scores

Liu et al, 2005

- Mental imagery of specific task + traditional therapy vs. Functional training of specific task + traditional therapy
- Method
  - Over 3 weeks, trained to perform 3 sets of daily tasks for 1 hr./ day
- Results
  - Mental imagery group had higher ADL function than mental imagery + functional training

Visual Mental Practice

Ertelt et al, 2007

- Method
  - Watch video of upper limb movement & perform movement VS. watch video of geometric shapes & perform movement
- Results
  - Significant improvement in video group of upper limb movement that sustained for at least 8 weeks
Mental Practice Evidence

- Nilsen, et al., 2010
  - “Consistent and positive outcomes have been documented, including decreased upper extremity impairment, increased upper extremity function, and increase in everyday use of the limb outside of structured therapy”

- Jackson, 2001
  - “Data from psychophysical, neurophysiological, and brain imaging studies support the existence of a similarity between executed and imagined actions”

Systematic Reviews

- Teasel, 2009 ebrsr.com
  - “There is strong evidence that mental practice may improve upper-extremity motor and ADL performance following stroke”

- Nilsen, et al., 2010
  - “When added to physical practice, mental practice is an effective intervention. Further research is warranted to determine who will benefit, dosing, and most effective protocols”

Motor Recovery and Electrical Stimulation after Stroke

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Cyclic Neuro Muscular Electrical Stimulation (NMES)

- Does not require active participation
- Goals
  - Decrease spasticity
  - Muscle strength
  - Reduce edema
  - Improves motor impairment in mild to moderate stroke

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### Electro Myograph Generated (EMG) - Triggered

- Must actively move to reach established threshold to “trigger” NMES to activate

### Outcome

- Increased function
- Decreased motor impairment
- Increase ability to concentrate (specifically on using the affected side of the body)
- Enhance behavioral training (active pt participation)
- Marked increase in reaction time
- Increase AROM

---

### EMG-Triggers ES

- How does it work?
  - Set stimulation intensity and EMG threshold
  - Electrodes sense trace contraction/muscular attempt
  - Device rewards patient with stimulation
  - Begin sequence again...

(Hill-Herman, 2010)

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### EMG – Triggered NMES

- Effective for flaccid upper limb as well
  (Page & Levine, 2006)
  - EMG triggered NMES for wrist extension and qualify for CIMT program

- Bilateral movements
  (Cauraugh et al., 2005)
  - Bilateral motion vs. unilateral vs. no protocol
  - Significant improvements in bilateral motion group

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Photos from personal collection of Christine Griffin. Used with permission.
EMG – Triggered NMES Video Exercise & Functional Use

Functional Electrical Stimulation (FES)

- Cyclic NMES during functional movements and functional activity
- Goals:
  - Improve hand function and voluntary movement
  - Facilitate neuromuscular reeducation
  - Regulate muscle tone (decrease spasticity)
  - Prevent atrophy - muscle strengthening
  - Initiate and regain voluntary motor functions (muscle reeducation)
  - Enhance behavioral training
  (Hill-Herman, 2010)

FES purpose

- Adaptive
  - Similar to an adaptive device to be used in order to engage in functional activity
- Therapeutic
  - Used during therapy in order to retrain brain and muscles how to work and how to work together
- Supplemental
  - Can be used above and beyond what is done in treatment during home exercise program and can be combined with other interventions
  (Hill-Herman, 2010)

Traditional FES

- E-Stim applied to muscles to elicit limb movement in specific sequence during functional tasks
- NMES units, splints, and other supports may be used
- Patient actively moves limb to engage in activity (task specific and client centered)
Neuro-prosthesis for FES

• Orthoses with embedded electrodes
• Custom fit to individual
  – Extensor panel
  – Flexor panel
  – Inserts
  – Straps

Video for FES
Functional Use & Gravity Eliminated AAROM

Photos from personal collection of Christine Griffin. Used with permission.

NMES – Neuro Muscular Electrical Stimulation Evidence

• Systematic Review: EBRSR, 2013
  – There is strong (Level 1a) evidence that FES treatment improves upper extremity function in acute and chronic stroke.
  – There is moderate (Level 1b) evidence that EMG-triggered FES is not superior to cyclic FES.
  – Functional Electrical Stimulation therapy improves hemiparetic upper extremity function.

Photos from personal collection of Christine Griffin. Used with permission.
Shoulder Subluxation & NMES

- **Surface NMES**
  - Muscles stimulated
    - Posterior deltoid
    - Supraspinatus
  - Prevents and reduces subluxation
    (Faghri et al., 1994; Chantraine et al., 1999)
  - **Recommended Protocol**
    - 6 hours daily, five days a week for 6 weeks (Paci et al. 2005)

Shoulder Subluxation - Surface NMES

- **Rationale**
  - Re-education of glenohumeral joint muscles
  - Repositioning of humeral head
  - Improved joint alignment can provide stable base for improved functional use of upper limb
- **Evidence: NMES for shoulder subluxation**
  - There is strong (Level 1a) evidence that electrical stimulation helps to prevent the development of shoulder subluxation, does reduce shoulder subluxation,
  - There is strong (Level 1a) evidence that electrical stimulation does not reduce hemiplegic shoulder pain following stroke. (Teasell, 2012)

Percutaneous Stimulation

- Physiatrists inserts electrodes into rotator cuff muscles
  - Outpatient surgery with general anesthesia
  - Port remains in shoulder, pads removable
  - Neurocontrol – Medtronic
    (Yu, et al., 2001)

Shoulder Subluxation Stimulation

- **Percutaneous stimulation**
  - Decreases shoulder pain:
    - Immediately following treatment
    - 3 months after treatment
    - 6 months after treatment
      (Yu, et al., 2004; Chae, Yu, & Walker, 2001)
Constraint Induced Movement Therapy (CIMT)

- Forced use to counteract learned nonuse
  - Patient unsuccessful with use of affected limb, so would stop initiating use of limb during tasks
  - Restraint of unaffected hand/ arm

- Motor inclusion criteria
  - 10 MCP extension and 20° wrist extension
  - Distal function is a critical factor
    (Gillen, 2011)

Constraint Induced Movement Therapy (CIMT)

- Main factor – Massed practice during repetitive functional activities
  - Restriction of less affected arm 90% of day during a 2 week period
  - Participation in upper limb therapy program 6hrs/day during the 2 week period
  - Shaping is very important (picking appropriate activities)
    - Select tasks that address the motor impairment and patient is able to carry out parts of the motor sequence
    - Has direct relationship to success of treatment
      (Taub et al., 1999)

EXCITE: Trial, Wolf et al, 2006

- EXCITE: Extremity Constraint – Induced Therapy Evaluation
  - Multi-Center, 222 subjects, over 3 yrs
  - 6 hrs/ day, 5 days/ week, 2 weeks
  - Significant improvement in Wolf Motor Function Test and Motor Activity Log
  - Lasted 24 months later

CIMT

- Neuroplasticity
  - Induces cortical representation of the affected upper limb
  - Effects sustained for at least 2 years after intervention
  - Beneficial treatment for patients with some active wrist and hand motion
    - Taub et al, 2006
    - Boake et al, 2007
    - Dahl et al, 2008
    - Myint et al, 2008
Modified CIMT

- Dosing
  - Restriction of less affected arm 5 hrs/day, 5 days/wk
  - Participation in upper limb therapy program 1 hr/day, 3 days/week, 10 weeks
- mCIMT performed better on Fugl-Meyer and Action Research Arm test than “usual care” following treatment and at 12 month follow up

CIMT -Timing

- Teasel, ebrsr.com
- Acute
  - “There is conflicting evidence of benefit of CIMT in comparison to traditional therapies in the acute stage of stroke”
- Chronic
  - “There is strong evidence of benefit of CIMT and mCIMT in comparison to traditional therapies in the chronic stage of stroke. Benefits appear to be confined to stroke patients with some active wrist and hand movements, particularly those with sensory loss and neglect”

References

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- Occupational Therapy Practice Guidelines for Adults with Stroke, The AOTA Practice Guidelines Series
- Stroke Rehabilitation, A function-based Approach by Glenn Gillen

Questions?