Physical modalities in the treatment of neurological dysfunction

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Historical overview

• Poliomyelitis epidemic
  – Muscle re-education
• Central nervous system disorders
  – Compensatory strategies, e.g. bracing
Upper motoneuron syndrome

Positive features
• Abnormal reflexes
• Spasticity

Negative features
• Weakness
• Loss of dexterity

Burke 1988  *Adv Neurol* 47:401-423
Neurotherapeutic approaches

- Bobath concept/NDT
- Rood
- Proprioceptive Neuromuscular Facilitation
- Contrast with “orthopaedic approach”
Bobath concept/NDT

Emphasis on:

– functional tasks, weight-bearing through affected limbs
– Need to inhibit spasticity

Bobath 1970 Adult Hemiplegia: Evaluation and Treatment
Proprioceptive Neuromuscular Facilitation (PNF)

- Diagonal, spiral patterns
- Quick stretch
- Resistance

Voss et al. 1985 *Proprioceptive Neuromuscular Facilitation* 3rd ed
Margaret Rood

- Therapeutic exercise based on ontogenetic sequence
- Cutaneous stimulation – brushing, icing

Facilitation techniques

• Quick stretch
  – enhances force development in a contracting muscle
  – Contraction linearly proportional to level of isometric contraction

• Traction
  – Enhances movement

• Approximation
  – Promotes stability

Webber & Kriellars, 1997 J Appl Physiol 83:40-45
Facilitation techniques

Brushing
• Immediate facilitatory effect but not sustained

Quick icing
• Decreases skin temperature by 7°
• Alters excitability of spinal motoneurons

Whole Body Vibration

- Improvements in blood flow, muscle strength
- Peak voluntary torque generated at longer muscle length

Electrical stimulation of peripheral nerve

Electrical stimulation for cauda equina injury

Kern et al *Neurorehabil Neural Repair* 2010; 24:709-721

Time of commencing stimulation post-injury

- 5.4 yrs
- 3.2 yrs
- 1.7 yrs
- 1.2 yrs
- 0.8 yrs
Functional electrical stimulation

Electrodes applied to large muscle groups

Multi-channel stimulator

Gater et al. 2011 NeuroRehabilitation 28:231-248
Inhibitory techniques

Inhibitory casts / serial casts

Prolonged icing

Motor Relearning Framework

Theoretical framework based on:

- Motor learning
- Motor control
- Biomechanics
- Muscle biology
- Task-specific training

Dynamical systems theory

• Emphasis on process rather than hierarchic structures
• Multiple subsystems contribute to motor behaviour
  – Neurological
  – Biomechanical
  – Psychological
  – Task
  – Context

Kelso 1995 *Dynamic Patterns: The Self-Organization of Brain and Behaviour*
Dynamical action/synergetics perspective

• Motor control
  – How do patterns and organization come into being from their constituent parts?
  – How do these systems change over time? (non-linear properties of the system; transitions in behaviour)
• Task-specificity and context of the action
  – opportunities for practice
• Behaviour as an emergent

Implications for therapeutic practice

• Are there constraints in subsystems that limit motor behaviour? (e.g. contractures, weakness)
• Does the therapeutic environment afford opportunities to practise tasks in a meaningful and functional context?
• Do activities promote exploration of a variety of movement patterns?
• Manipulate control parameters such as speed or force to facilitate attainment of therapeutic goals