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Clinical application of evidence-based interventions to improve upper extremity motor recovery post-stroke

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Course Objectives

By the end of this presentation, participants will be able to:

- Understand the concepts of neuroplasticity
- Identify the critical window for therapeutic interventions to maximize neurologic recovery post-stroke
- Identify the recommended measures for UE assessment post-stroke
- Describe the use of neuromuscular electrical stimulation (NMES) as a motor relearning tool in reducing UE motor impairment & shoulder subluxation
- Describe the precautions & contraindications in use of e-stim/NMES
- Understand other evidence-based interventions in improving UE motor recovery/function

Stroke Statistics[2]

- Every year, more than **795,000 people** in the United States have a stroke (1 every 40 seconds). About 610,000 of these are first or new strokes.
- About 185,00 strokes—**nearly 1 of 4**—are in people who have had a previous stroke.
- About **87%** of all strokes are ischemic strokes, in which blood flow to the brain is blocked.
- Economic impact was estimated at **$34 billion** each year. This total includes the cost of health care services, medicines to treat stroke, and missed days of work.
- Stroke is a **leading cause of serious long-term disability**.

Upper Extremity Motor Impairment

- 80% of stroke survivors report upper extremity deficits which is a major contributor to loss of independence. [3]
  - Shoulder Subluxation
  - Weakness on scapula
  - Hypotonus / Flaccidity
  - Hypertonus / Spasticity
- 20% have entirely normal function
- 40% have mild to moderate impairments
  - Good prognosis for functional recovery, these patients achieve at least some dexterity at 6 months post-stroke[10]
- Only 5% of patients who initially experienced complete paralysis achieve functional use of their arm[10]

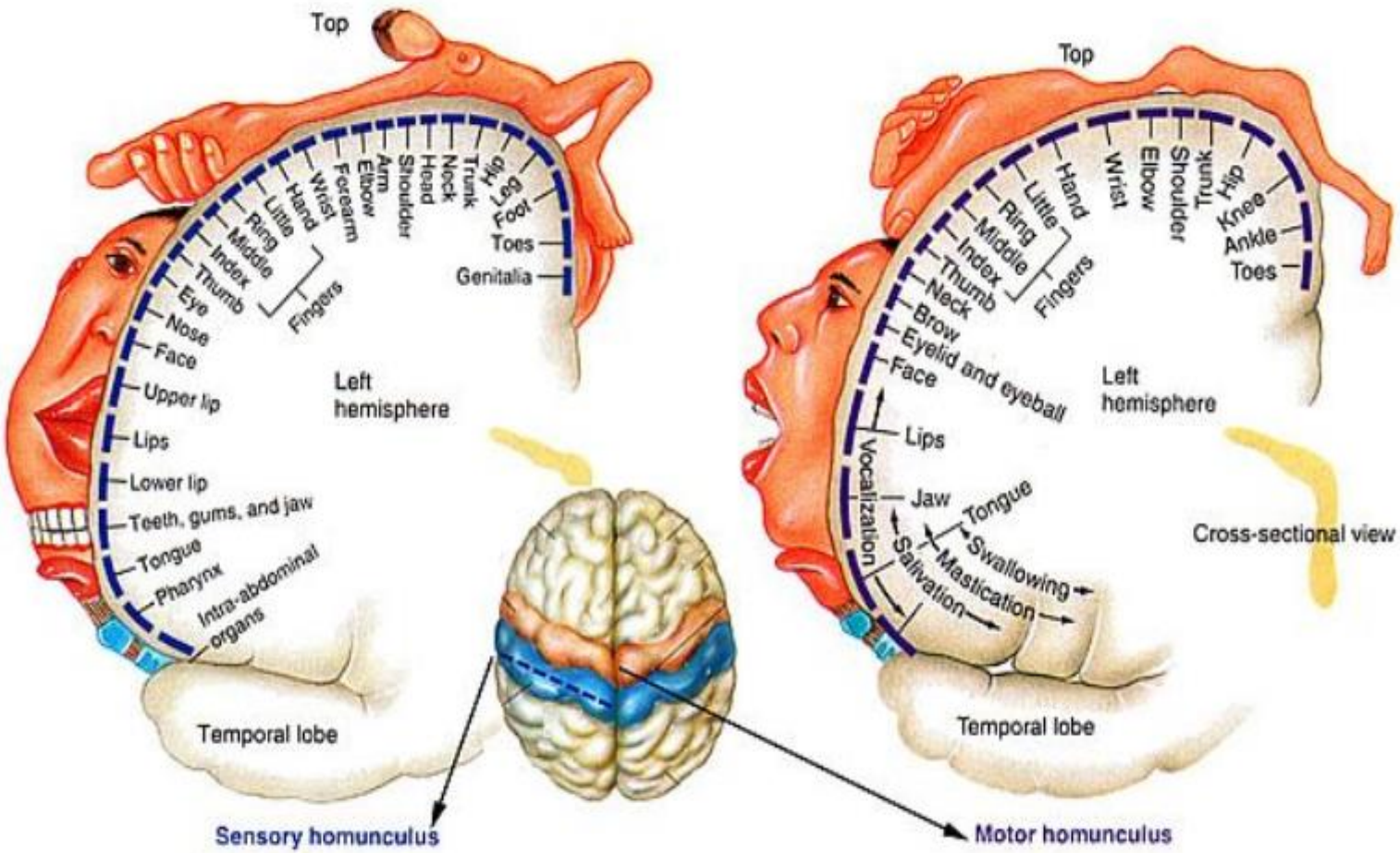
When should rehabilitation commence after stroke?[14]

- Evidence from animal studies shows that a cascade of genetic, cellular & electrophysiological events is triggered which promote neural recovery
- These events drive cortical reorganization & regeneration, and provide the neural substrate for spontaneous recovery
- **Begin within hours after stroke, peak at 7-14 days, and nearly complete at 30 days**
- Concern have emerged in animals & human trials that **rehabilitation delivered too early or too intensely during the very early period (within 24H after stroke) may be harmful**

Post-stroke neuroplasticity (cortical reorganization)[14]

- A process in which functions of the damaged brain migrate to other uninjured brain regions
- Studies in mice, within 1-3 days of stroke, stimulation of limbs contralateral to the stroke produces activity in the ipsilateral cortex indicating reorganization of sensory inputs to the intact hemisphere
- By 1-2 weeks post-stroke, activity shifts back to the uninjured hemisphere, with spared perilesional cortex taking on functions of the damaged brain

Motor Homunculus



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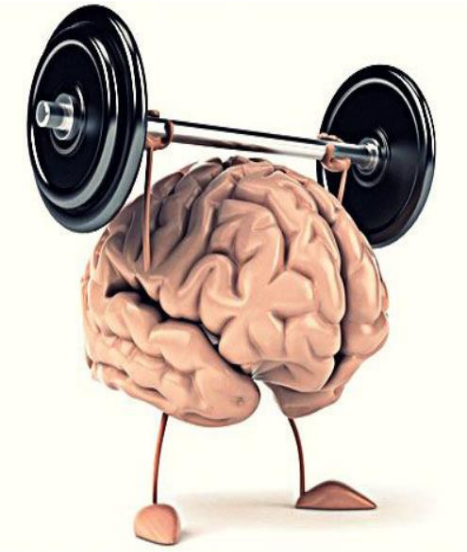
Motor recovery of upper extremity post-stroke

- Timeframe [4, 5]
  - **Hyperacute**: 1st symptom to 6H
  - **Acute**: 1st month (offers the highest rate of recovery) [6]
  - **Sub-acute**: 1 month to 6 months
  - **Chronic**: > 6 months
- Initial days & weeks represent a critical window for therapeutic interventions to maximize neurologic recovery of body functions & activities
- Recovery occurs through spontaneous neurologic process such as reperfusion (return of blood supply) to tissue and reduction of swelling to minimize cortical damage
- Neuroplasticity is driven by functional demand & practice and it is the aim of therapeutic interventions to facilitate cortical reorganization

10 Principles of Neuroplasticity Simplified[15]

- **Principle 1: Use it or Lose it**
  The skills we don't practice often get weaker. If you don't give the hand or leg an opportunity to work, it will stop working because you are not engaging the area of the brain often enough.
- **Principle 2: Use it and Improve it**
  This one is pretty self explanatory. The skills we practice will get better. Great!
- **Principle 3: Specificity (it needs to be a specific task)**
  We must do the task we want to improve. The task has to be challenging and lead to skill learning, not just repeated movement.
- **Principle 4: Repetition Matters**
  If you're practicing your rehab exercises sporadically, you're not going to see results. Your brain needs a high number of repetitions in order to successfully rewire itself and heal.
- **Principle 5: Intensity Matters**
  More repetitions in a shorter time are necessary for creating new connections.



10 Principles of Neuroplasticity Simplified[15]

- **Principle 6: Time Matters**
  The earlier you can start therapy after your stroke or injury, the better. Research shows you can always make improvements, but the greatest opportunity for brain changes is early on.
- **Principle 7: Salience Matters (it needs to be important or meaningful)**
  To change the brain, the skill we're practicing must have some meaning, relevance, or importance to us.
- **Principle 8: Age Matters**
  You can teach an old dog new tricks, but younger brains tend to change faster than older brains. It's just how it is.
- **Principle 9: Transference**
  Practicing one skill can result in improvement of a related skill. For example, practicing pinching a cube can lead to being able to pick up a grape.
- **Principle 10: Interference**
  Learning an "easier way" of doing something (i.e. a bad habit or compensation) may make it harder to learn the proper way. So even if it's more difficult, try to perfect your movements.

Time allocated to upper extremity therapy after stroke is minimal[7,8]

Serrada I, McDonnel MN, Hillier S (2016)

- **Systematic Review:** to investigated the amount of time and types of interventions used during therapy sessions in the acute setting following stroke.
- **Inclusion Criteria:** Studies were eligible if they were observational studies of adults with a confirmed diagnosis and within 4 weeks post-stroke; receiving Physiotherapy (PT) and/or Occupational Therapy (OT); and the outcome included amount of therapy time devoted to upper extremity and/or types of interventions.
- **Results**: 94 studies reviewed, seven studies involving 3236 participants met the inclusion criteria. Pooled results indicated that **7.9 min/day (21.4%) of a total 36.7 min/day combined PT and OT session was devoted to upper extremity therapy**.
- **Conclusions**: A small proportion of total PT and OT time is directed to the involved Upper Extremity during acute rehabilitation.

Time allocated to upper extremity therapy after stroke is minimal[7,8]

Hayward K, Brauer S (2015)

- **Systematic review** of PubMed, CINAHL and EMBASE up to December 2014 was completed to determine the dose of activity-related arm training undertaken by stroke survivors during acute & subacute rehabilitation
- **Inclusion Criteria:** Studies were eligible if they defined the dose (time or repetitions) of activity-related arm training using observational methods, environment (acute or subacute rehabilitation) and therapy discipline (physiotherapy, occupational therapy).
- **Results:** 10 studies were included; During **acute rehabilitation**, one study reported 4.1 minutes per session during physiotherapy and 11.2 minutes during occupational therapy, while another study reported 5.7 minutes per session during physiotherapy only. During **inpatient rehabilitation**, activity-related arm training was on average undertaken for 4 minutes per session (range 0.9 to 7.9, n = 4 studies) during physiotherapy and 17 minutes per session (range 9.3 to 28.9, n = 3 studies) during occupational therapy. Repetitions per session were reported by two studies only during subacute rehabilitation. One study reported **23 repetitions** per session during physiotherapy and occupational therapy, while another reported **32 repetitions per session across both disciplines**.
- **Conclusions:** The dose of activity-related arm training during acute & subacute rehab after stroke is limited.

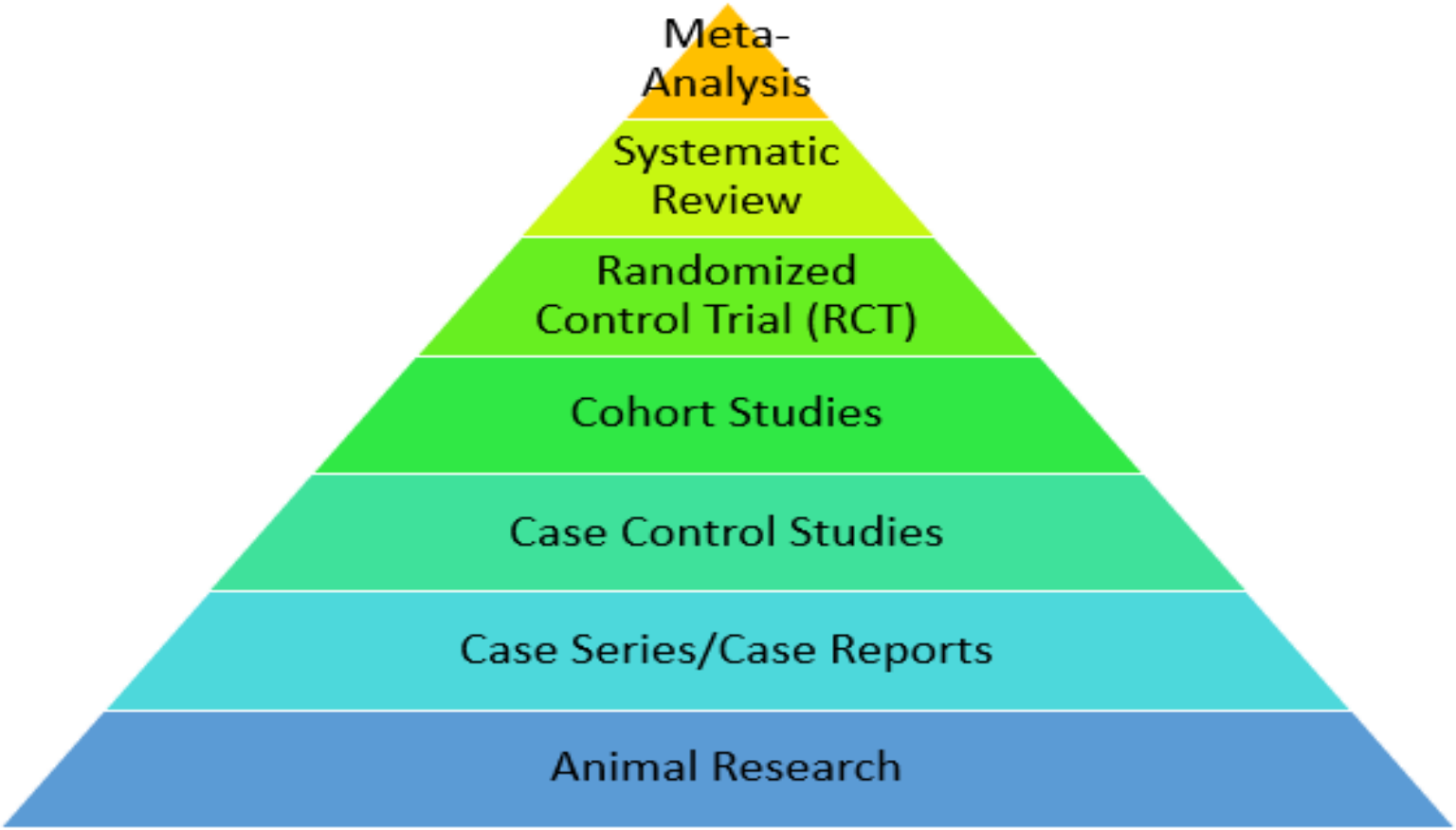
Recommended UE Assessment Measures [11]

- Chedoke McMaster Stroke Assessment (CMSA)
- Arm Motor Fugl-Meyer (AMFM)
- Action Research Arm Test (ARAT)
- Modified Ashworth Scale (MAS)
- Motor Activity Log (UE MAL: Amount of Use AoU; How Well Scale)
- ROM*
- Muscle Strength
- Grip & Pinch Strength
- Box & Block Test
- Nine Hole Peg Test*

Selection of interventions to facilitate patient participation vary between practitioners[19]

- OTs have professional & ethical responsibility to ensure that we optimize the outcomes & the use of tools and strategies that will enable patients return to functional and meaningful life[19]
- Some of the primary reasons therapists select the interventions that they do is based on the professional training they receive in school or conferences, or on the resources available at their worksite[20]
- A questionnaire regarding preferred practice methods was given to 107 experienced OTs and indicated that 85% were using interventions for stroke that are not scientifically supported[21]
- What is most concerning is that there appears to be an underlying, yet pervasive resistance by OTs to adopt evidence-based practice methods or to implement new technologies that have demonstrated effectiveness.[19]

Hierarchy of Evidence



Hierarchy of Evidence[35,36]

- **Meta-Analysis** A systematic review that uses quantitative methods to summarize the results.
- **Systematic Review** An article in which the authors have systematically searched for, appraised, and summarized all of the medical literature for a specific topic.
- **Randomized Controlled Trials** RCT's include a randomized group of patients in an experimental group and a control group. These groups are followed up for the variables/outcomes of interest.
- **Cohort Study** Identifies two groups (cohorts) of patients, one which did receive the exposure of interest, and one which did not, and following these cohorts forward for the outcome of interest.
- **Case-Control Study** Involves identifying patients who have the outcome of interest (cases) and control patients without the same outcome, and looking to see if they had the exposure of interest.
- **Background Information / Expert Opinion** Handbooks, encyclopedias, and textbooks often provide a good foundation or introduction and often include generalized information about a condition. While background information presents a convenient summary, often it takes about three years for this type of literature to be published.
- **Animal Research / Lab Studies** Information begins at the bottom of the pyramid: this is where ideas and laboratory research takes place. Ideas turn into therapies and diagnostic tools, which then are tested with lab models and animals.

Neuromuscular Electrical Stimulation (NMES) / E-stim

- NMES is an intervention that is not "occupation-based" and is not congruent with the historical foundations of OT. Perhaps this controversy has resulted in a decreased enthusiasm for NMES.[19]

- One of the reasons OTs do not use electrical stimulation as often as other modalities is that many curricula teach NMES at an introductory level, recommending that further professional education be obtained post-graduation to acquire full proficiency.[22]

What is Electrical Stimulation (E-Stim) or Neuromuscular Electrical Stimulation (NMES)?

- NMES involves the use of an electrical stimulator that transmits an electrical impulse through the skin. Electrodes, controlled by a unit, are placed on the skin over a predetermined area to activate muscles through stimulation of intact peripheral motor nerves. Electrical current is then sent from the unit to the electrodes and delivered into the muscle causing a contraction. The electrical current setting can be changed to allow for a forceful or gentle muscle contraction.

- Functional Electrical Stimulation (FES) is the use of NMES to promote functional movements.

Indications of Electrical Stimulation (E-Stim) or Neuromuscular Electrical Stimulation (NMES)

Some of the benefits of NMES includes:

- Muscle re-education / Strengthening
- Prevention or retardation of muscle atrophy
- Relaxation of muscle spasm
- Decrease spasticity
- Maintain or increase ROM
- Reduce edema
- Increase blood circulation
- Improve overall function

Contraindication / Precautions of E-Stim or NMES

Contraindications:

- When stimulation of cell proliferation is contraindicated, i.e. malignancy (active, local or potential for mets)
- Where there are metal ions or topical preparation residues, i.e. povidone-iodine, zinc, silver, calcium, sodium chloride
- Where the placement of electrodes could adversely affect a reflex center, i.e. the carotid sinus, heart, parasympathetic nerves, ganglion, laryngeal muscles, phrenic nerve
- Where electrical current could affect the function of an electronic implant, i.e. over a cardiac pacemaker
- Untreated osteomyelitis or immature bone
- Over a pregnant uterus
- Inflammatory ulcers
- Over an active deep vein thrombosis or thrombophlebitis
- In the presence of severe arterial insufficiency, i.e. ABI < 0.5

Contraindication / Precautions of E-Stim or NMES

- **Precautions**
  - Severe peripheral vascular disease
  - Over areas of impaired sensation and over regenerating nerves
  - In those with impaired cognition
  - Over superficial metal implants, i.e. surgical staples
  - In those on anticoagulants or at risk for hemorrhage
  - Over an area of gross edema, scar tissue, or broken skin
  - In those with heart conduction problems, i.e. atrial fibrillation
  - Those with autonomic dysreflexia
  - In those with adhesive allergies
  - Over tissues with high resistance to electrical current, i.e. bone
  - Factors increasing skin impedance include the presence of hair and oil and cooler skin color

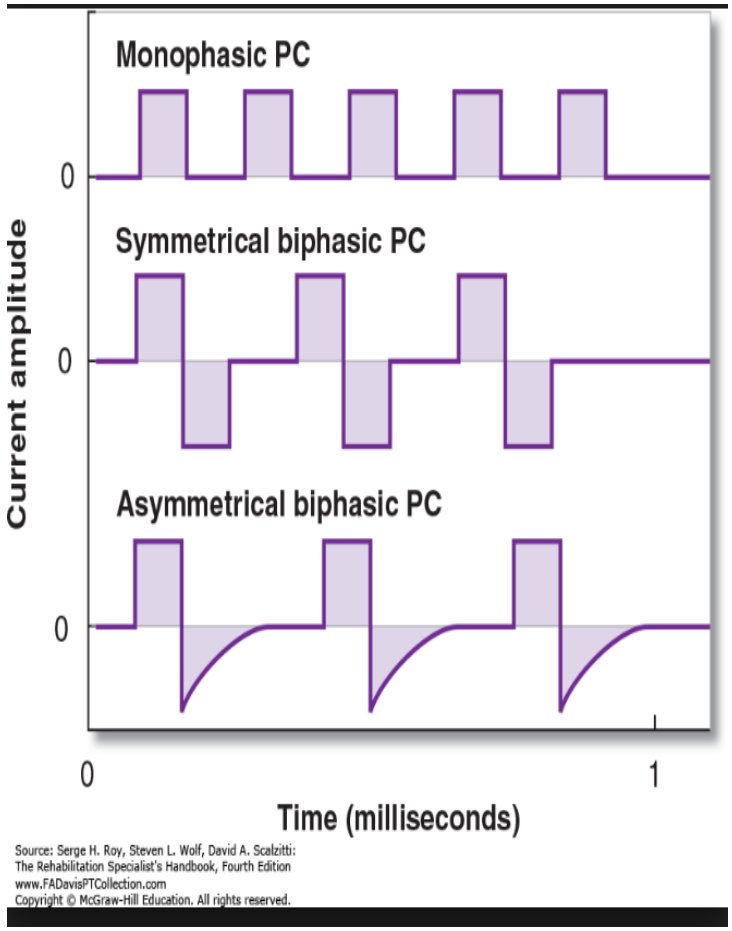
- **Adverse Reactions**
  - Some patients may experience skin irritation or hypersensitivity to the electrodes or gel
  - Tissue burn

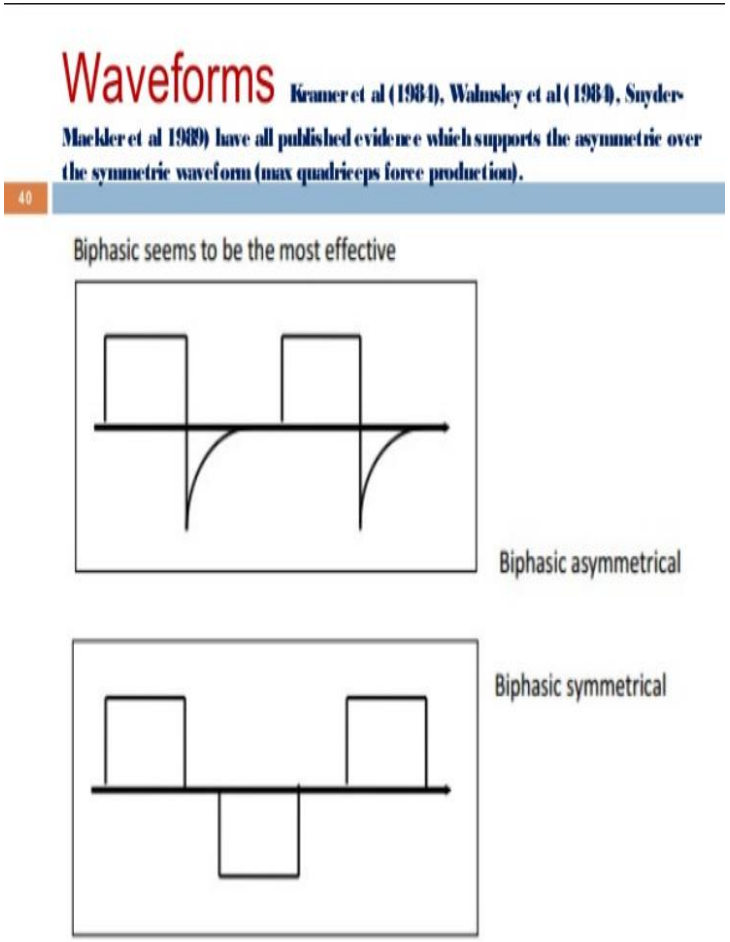
Effects of Stimulus Waveform

- Stimulus waveform in combination with pulse duration can play a major part in subject comfort. An asymmetric balanced biphasic square waveform was perceived as comfortable and was clinically effective in stimulating wrist flexor and extensor muscles. Subjects preferred the square waveforms over a paired spike monophasic waveform.
- In the larger quadriceps muscle group, a symmetric biphasic square wave was perceived as more comfortable than either a monophasic paired spike or any of three medium frequency waveforms. There seemed to be, however, a small subpopulation of subjects who consistently preferred the medium frequency waveforms.
- Medium frequency stimulation should be tried for those patients who have considerable difficulty adapting to the sensory input inherent with the use of surface electrical stimulation

Baker LL[1], Bowman BR, McNeal DR (1988). *Effects of Waveform on Comfort During Neuromuscular Electrical Stimulation;* Clin Orthop Relat Res. Aug;(233):75-85. [14]

E-stim Waveforms





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Evidence to stimulate UE motor recovery after stroke

Wattchow K, McDonnel M, Hillier S (2018)[9]

- **Systematic review t**o investigate the therapeutic interventions reported in the research literature and synthesize their effectiveness in improving upper limb (UL) function in the first 4 weeks poststroke.
- **Methods:** Electronic databases and trial registries were searched from inception until June 2016, studies were assessed using the Cochrane Risk of Bias Tool.
- **Inclusion Criteria**: Randomized controlled trials (RCTs), controlled trials, and interventional studies with pre/posttest design were included for adults within 4 weeks of any type of stroke with UL impairment. Participants all received an intervention of any physiotherapeutic or occupational therapeutic technique designed to address impairment or activity of the affected UL, which could be compared with usual care, sham, or another technique.
- **Results**: A total of 104 trials (83 RCTs, 21 nonrandomized studies) were included (N=5225 participants). Meta-analyses of RCTs only (20 comparisons) and narrative syntheses were completed. Key findings included significant positive effects for modified constraint-induced movement therapy (mCIMT) (standardized mean difference and task-specific training**. Evidence was found to support supplementary use of biofeedback and electrical stimulation**.
- **Conclusions:** Use of mCIMT and task-specific training was supported, as was supplementary use of biofeedback and electrical simulation, within the acute phase poststroke.

Evidence in use of NMES to stimulate UE motor recovery after stroke

Hatem S, Saussez G, Della Faille M, et.al. (2016) [10]

- **Multiple s**ystematic review focused on techniques to stimulate UE recovery
- **Results:** There is a moderate quality evidence that simple/passive NMES in combination with rehabilitation is superior to rehabilitation treatment alone with regards to UE impairment (strength, ROM). Treatment effects has been described in acute & subacute stroke patients.
- **Conclusions:** NMES appears to be valuable and could be integrated as an adjuvant therapy into stroke rehabilitation strategies to improve UE motor impairments

Evidence of e-stim to reduce spasticity and ROM[18]

Stein C, Fritsch Ft CG, et.al (2015)

- **Methods:** A systematic review of randomized clinical trials (RCTs) from inception to February 2015 to assess the effect of treatment with NMES with or without association to another therapy on spastic muscles after stroke compared with placebo or another intervention
- The primary outcome extracted was spasticity, assessed by the Modified Ashworth Scale, and the secondary outcome extracted was range of motion, assessed by Goniometer. Studies with <3 days intervention were excluded
- **Results:** Of the total of 5066 titles, 29 randomized clinical trials were included with 940 subjects. **NMES provided reduction in spasticity** (−0.30 [95% confidence interval, −0.58 to −0.03], n=14 randomized clinical trials) **and increase in range of motion when compared with control group** (2.87 [95% confidence interval, 1.18–4.56], n=13 randomized clinical trials) after stroke.
- **Conclusions:** NMES combined with other intervention modalities can be considered as a treatment option that provides improvements in spasticity and range of motion in patients after stroke.

Evidence in use of NMES to stimulate UE motor recovery after stroke

Winstein C, Stein J, Arena R, et. Al. (2016). **Guidelines for Adult Stroke Rehabilitation & Recovery: A guideline for healthcare professionals** from the American Heart/American Stroke Association. http://stroke.ahajournals.org [11]

NMES is reasonable to consider for patients with minimal volitional movement within the first few months after stroke or for individuals with shoulder subluxation. (Class IIa, LOE A)

Clinical application of NMES

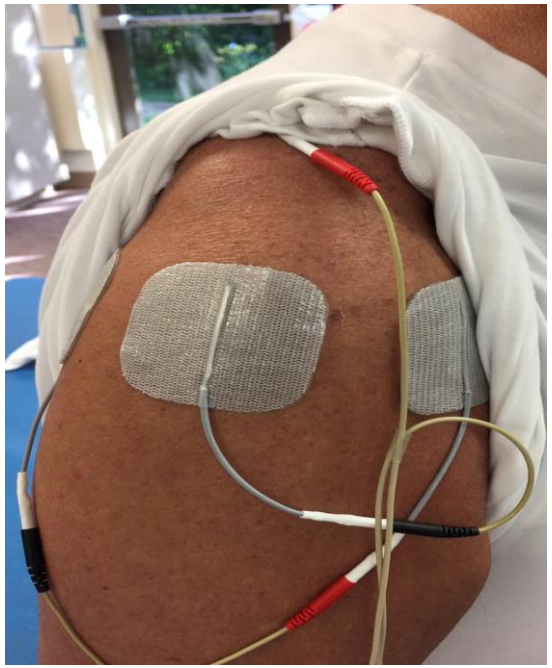
Shoulder Subluxation

- Partial separation of the humeral head from the glenoid cavity in the inferior direction (inferior subluxation)
- Develops as a result of a prolonged downward pull of gravity on the arm against hypotonic mm, resulting in overstretch of both the glenohumeral capsule and the hyotonic supraspinatus & deltoid mm
- There is no efficacy of shoulder slings in reducing subluxation however literature data suggest that NMES and use of sling are effective especially in the acute stage of hemiplegia (< 6 mos)

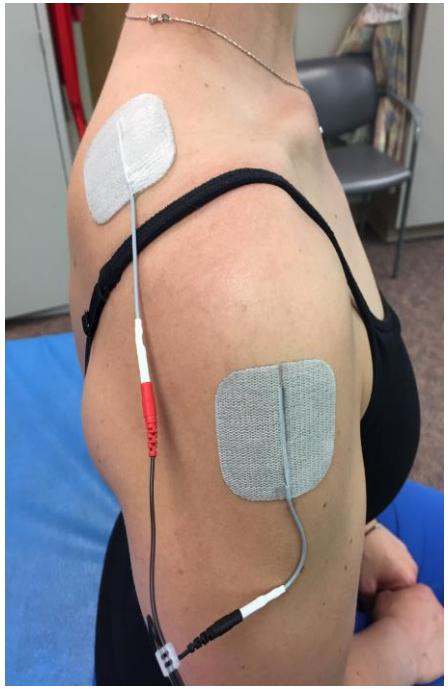
Vadafar A, Cote J, Archambault P (2015). *Effectiveness of FES in Improving Clinical Outcomes in the Upper Arm following Stroke: A Systematic Review & Meta-Analysis*. Biomed Research International, Article ID 729768 (1-14) [12]

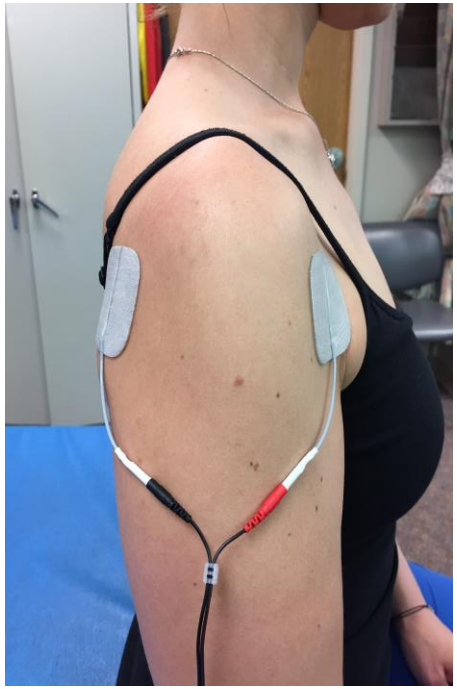
Lee J-H, Baker L, Johnson R, & Tilson J (2017). *Effectiveness of NMES for management of shoulder subluxation post-stroke: a systematic review with meta-analysis.* Clinical Rehabilitation, Vol. 3 (11) 1431-1444 [13]

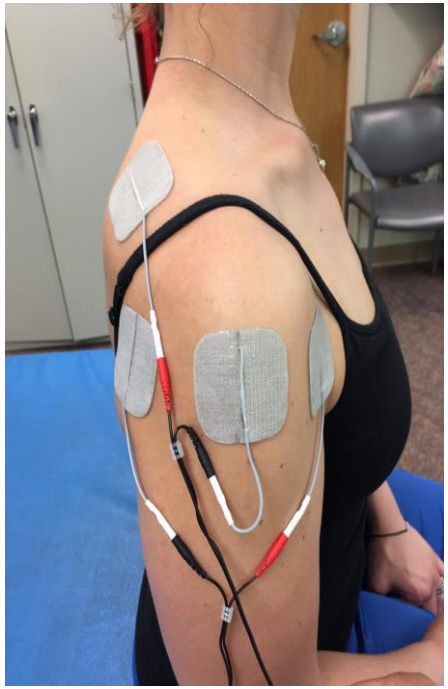
E-Stim on Shoulder Subluxation (video)



NMES: Electrodes Placement to address Inferior Shoulder Subluxation







Parameters: Mode Synchronous, Pulse Width 300us, Pulse Rate 30 to 45 Hz, 15:30 ON/OFF cycle, Ramp 2 secs; Intensity: _____ mA

Total treatment & frequency: 30 minutes, 3x/day, 5-7 days/week

Reference: Humphrey, L., Taylor, P., Kwan, Y-T,. Odstock Medical 2011[16]

Assessment (video)

Patient Education/Training on E-Stim Home Program (video)

Ambulation, Grasp-Release (video)


NESS
NESS

Modified Constraint-Induced Movement Therapy (mCIMT)[9,11,33,34]

- mCIMT is a variant of the CIMT protocol with the components of constraint of the nonparetic UL in a padded mitt, glove, or splint, with intensive, graded practice of the paretic UL
- Criteria: 20 degrees of wrist extension, 10 degrees of MP & IP extension and thumb abduction/extension
- CIMT has demonstrated to improve UE activity, participation, and quality of life in individuals with baseline ability to control wrist & finger extension compared with usual care; Class IIa, LoE A
- CIMT can be delivered in its original form 3 to 6H/day, 5 d/wk for 2 weeks or in a modified version 1H/day, 3 d/wk for 10 weeks
- Practice schedules varies from 30 minutes to 6 hours per session, 2 to 7 sessions per week, for 2 to 12 weeks

SAEBO Dynamic Orthosis

- SAEBOFlex is a mechanical, spring-loaded upper extremity thermoplastic orthotic that keeps neurologically flexed digits in an extended position so that persons with stroke can perform an active grasp with a spring-loaded assisted release. The device, in combination with a massed repetitive practice regimen, can facilitate motor and sensory relearning while reducing learned non-use

- Saebo additionally offers a static positioning device for the forearm, the SaeboStretch, which provides a prolonged static stretch to hypertonic wrist extensors; this device allows persons in the SaeboFlex training program to receive dual rehabilitative benefits of dynamic grasp-release training and static tissue remodeling. The SaeboFlex is extremely popular in clinics but there is a paucity of research available regarding its clinical effectiveness

SAEBOFlex Orthosis

Stuck R, Marshall L, Sivakumar R (2014). Feasibility of SAEBOFlex Upper-limb training in acute stroke rehab: A clinical care series. Occupational Therapy International, 108-114. [24]

- The study recruited stroke patients (< 84 days post-stroke) with moderate to severe UL weakness. They participated in SAEBOFlex training for 12 weeks (3 x45 mins/day) in addition to conventional rehab
- A battery of measures was taken at 4, 8, and 12 weeks
- Clinically significant improvement were noted in 5/7 (71%) and 6/7 (86%) on ARAT & UL Motricity Test respectively

SAEBO Orthosis

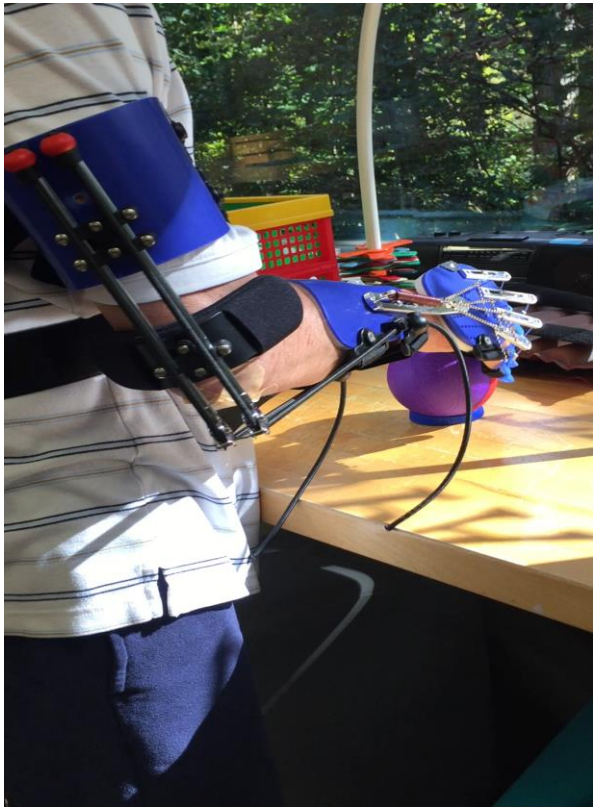
Doucet B, Mettler J (2018)[26]

- Pilot study to investigate the effect of combining neuromuscular electrical stimulation (ES) and dynamic hand orthosis (DHO) regimen with a group of people with chronic stroke to improve performance on specific daily tasks.
- **METHOD.** Four people with chronic stroke participated in an ES–DHO regimen using the affected upper extremity 5×/wk for 6 wk. Outcome measures included grip strength, range of motion (ROM), and analysis of muscle activation–deactivation during release of grasp through electromyography. Ability to perform specific daily living tasks was assessed using the Assessment of Motor and Process Skills (AMPS).
- **RESULTS.** Results suggested that improvements in strength, ROM, and grasp deactivation are possible with the combined ES–DHO regimen. All participants' AMPS motor scores improved.
- **CONCLUSIONS.** An ES–DHO regimen may improve motor skills needed for functional task performance in people with chronic stroke. Results should be interpreted cautiously because of the pilot nature of the study and the small sample size.

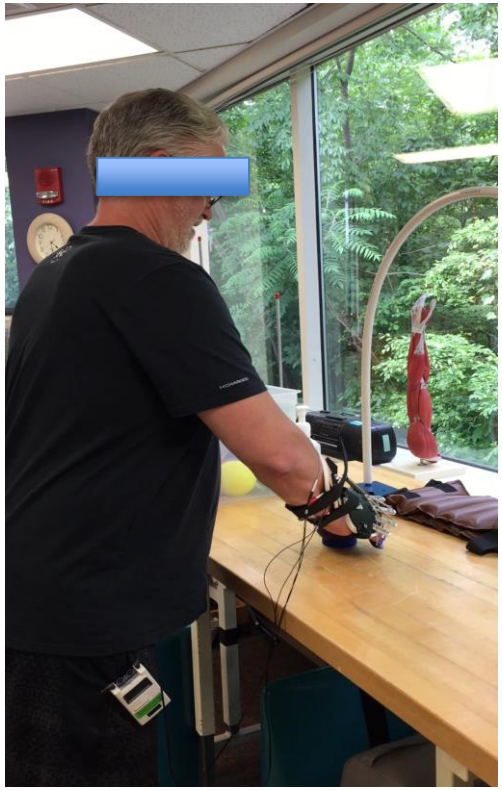
Minimum criteria to qualify for SAEBOFlex orthosis

- 15 degrees active shoulder movement in any plane
- 15 degrees active elbow flexion
- ¼ range of active finger flexion
- Full passive finger MP/IP extension with the wrist passively extended to 15 degrees minimal, 35 degrees optimal

SAEBO Reach



SAEBO Flex Orthosis w/o and w/ E-stim (video)



Robot-assisted Therapy

- The intent of robot-aided therapy is to induce cortical reorganization through sets of numerous repetitive movements. Robotic devices provide new options for repetitive movement training that can complement efforts to improve functional performance in daily activities
- This new technology has the potential to alleviate the labor- intensive aspect of physical rehabilitation – replicate some of the movement therapy performed by therapists
- It can provide intensive, reproducible, and task- specific movement therapy – digitized & quantify movement
- Robotic technology is not intended to replace the therapist but to carry out the repetitive practice that is needed to facilitate functional gains
- No robot could replicate the knowledge & experience of the therapist in assessing the needs of the patient and the outcome of the therapy program

Prange, G. et.al. (2006). Journal of Rehabilitation Research & Design

Fasoli, S. et.al. (2004). Top Stroke Rehab; 11(4): 11 –19)

Lum, P. et.al. (2002). Top Stroke Rehab; 8 (4); 40 – 53

Robot-assisted Therapy

Kim GY, et.al. (2017)[28]

- **Systematic review** to investigate the effects of robot-assisted therapy on the upper extremity in acute and subacute stroke patients; RCTs from 2012 to 2016
- 637 articles were searched, 6 met the inclusion criteria
- **Conclusion:** the review confirmed that the robot-assisted therapy with three-dimensional movement and a high degree of freedom had positive effects on the recovery of upper extremity motor function in patients with early-stage stroke. Robot-assisted therapy could be used to improve upper extremity function for early stage stroke patients in clinical setting.

Efficacy of Robot-assisted therapy

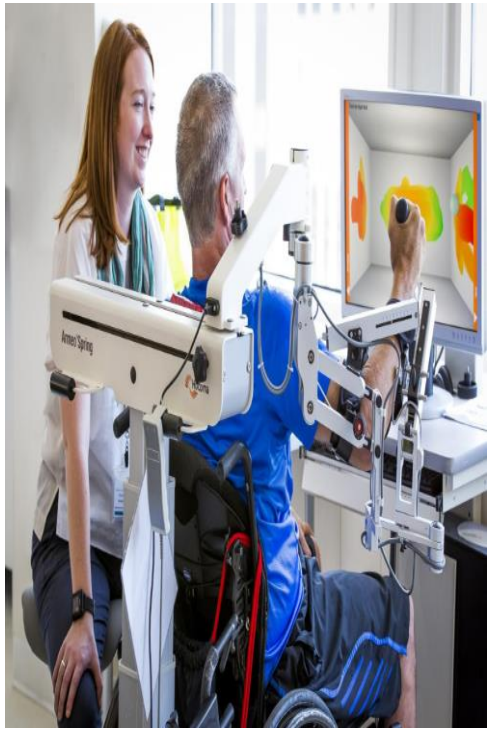
Sale P, et.al. (2014). [27]

- **Objective**: A randomized controlled trial was carried out to evaluate the short-time efficacy of intensive robot-assisted therapy compared to usual physical therapy performed in the early phase after stroke onset.
- **Method**: Fifty-three subacute stroke patients at their first-ever stroke were enrolled 30 ± 7 days after the acute event and randomized into two groups, both exposed to standard therapy. Additional 30 sessions of robot-assisted therapy were provided to the Experimental Group. Additional 30 sessions of usual therapy were provided to the Control Group. Outcome measures used: Fugl-Meyer Assessment Scale (FM), Modified Ashworth Scale-Shoulder (MAS-S), Modified Ashworth Scale-Elbow (MAS-E), Total Passive Range of Motion-Shoulder/Elbow (pROM), and Motricity Index (MI).
- **Result**: Evidence of significant improvements in MAS-S ($p = 0.004$), MAS-E ($p = 0.018$) and pROM ($p < 0.0001$) was found in the Experimental Group. Significant improvement was demonstrated in both Experimental and Control Group in FM (EG: $p < 0.0001$, CG: $p < 0.0001$) and MI (EG: $p < 0.0001$, CG: $p < 0.0001$), with an higher improvement in the Experimental Group.
- **Conclusion**: Robot-assisted upper limb rehabilitation treatment can contribute to increasing motor recovery in subacute stroke patients. Focusing on the early phase of stroke recovery has a high potential impact in clinical practice.

Examples of UE Robot Device

MIT-MANUS (Interactive Motion Technologies, Cambridge, MA)

REO-GoSystem (Motorika)

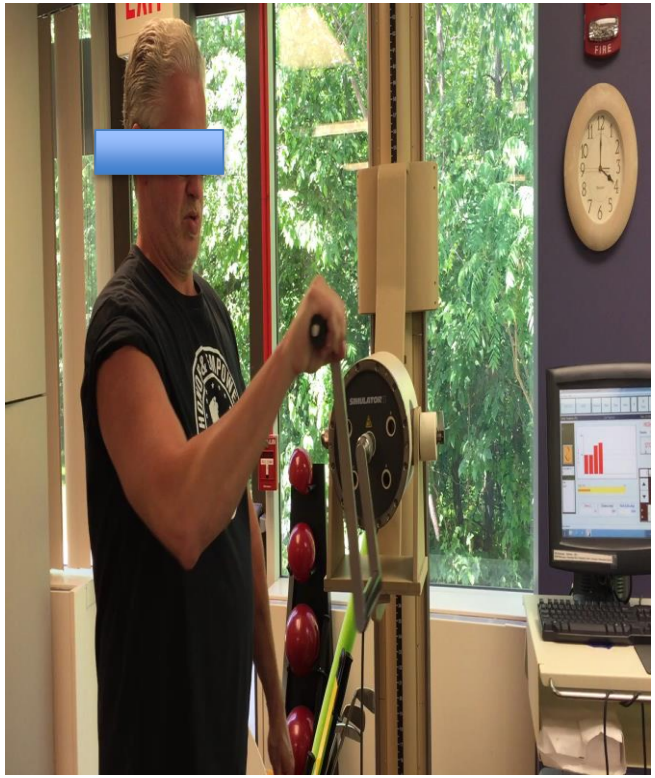


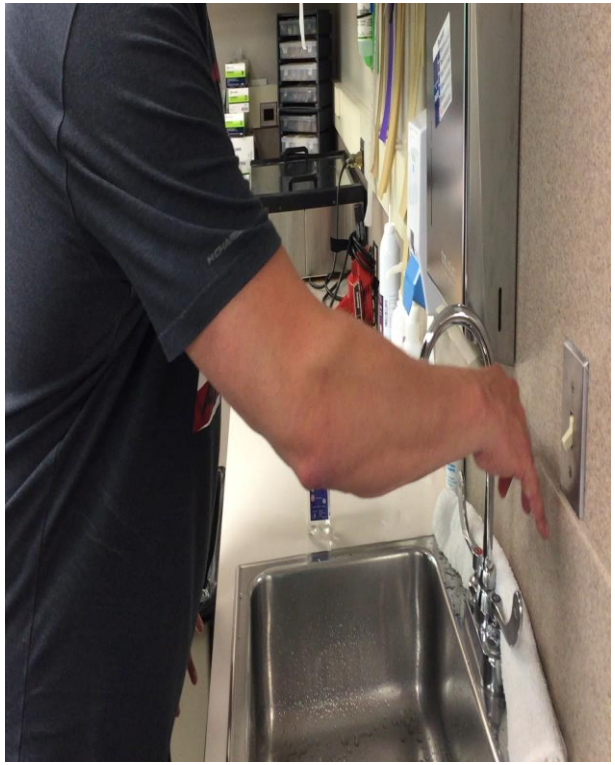
Armeo (Spring/Boom): Hocoma

Forced Use Therapy[10]

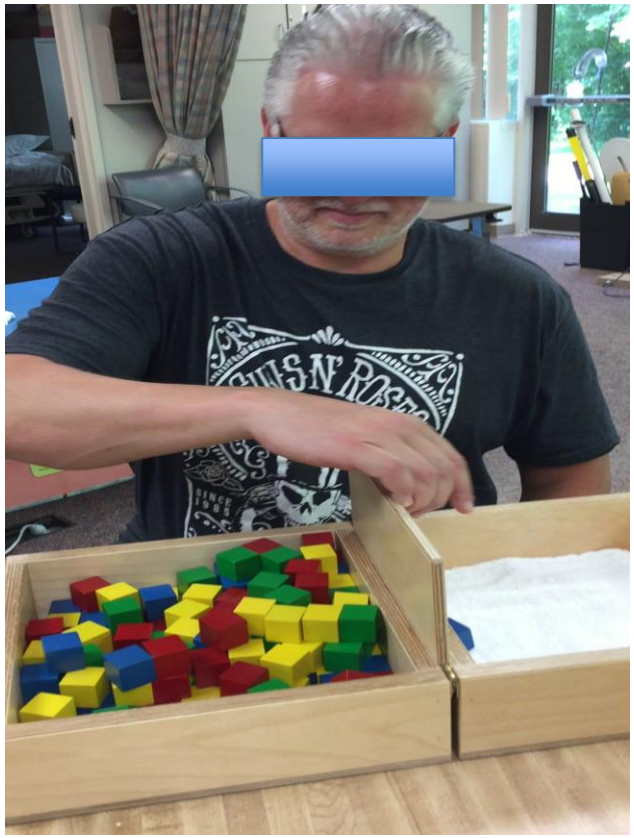
Forced-use consists in favoring the unimanual use of the paretic upper extremity by restraining the non-paretic upper extremity (by a cast, sling, mitten, etc.). However, in contrast with constraint-induced movement therapy, forced-use is not associated with specific motor skill learning techniques. Restraint of the non-paretic upper extremity is performed without specific training, or using usual care.

Forced Use (Video)

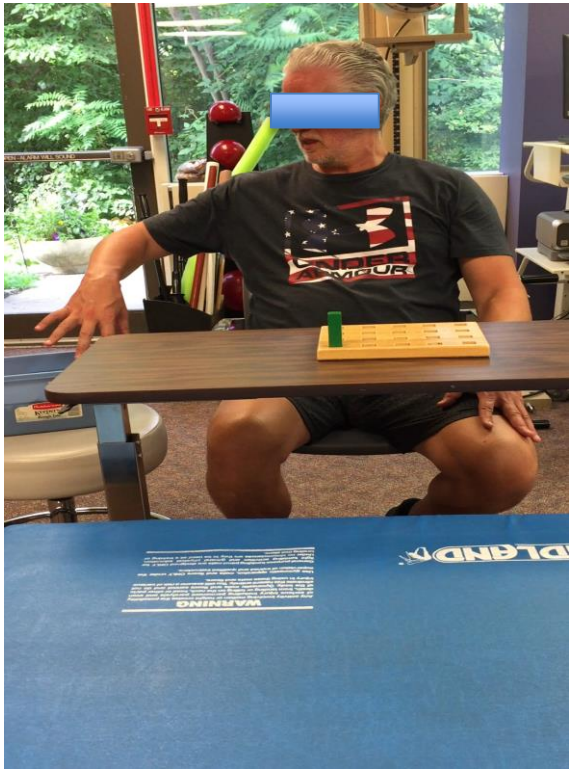




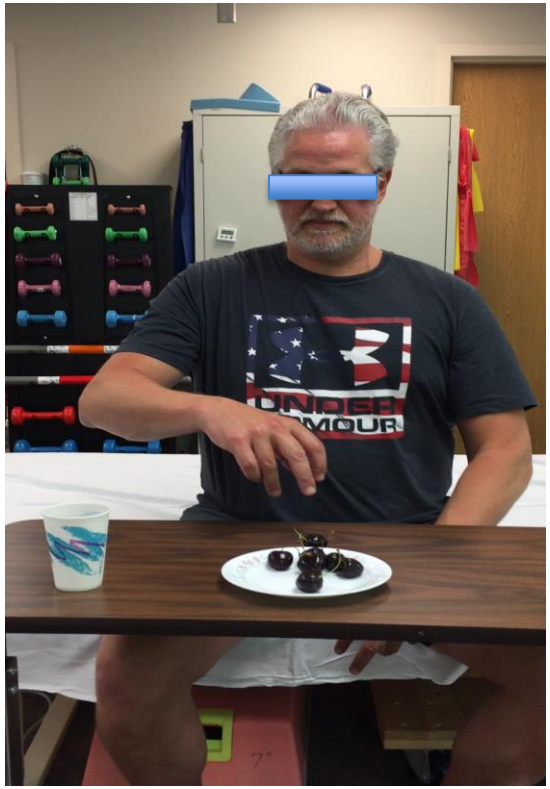
Prehension (video)



Prehension (video)



Prehension (video)

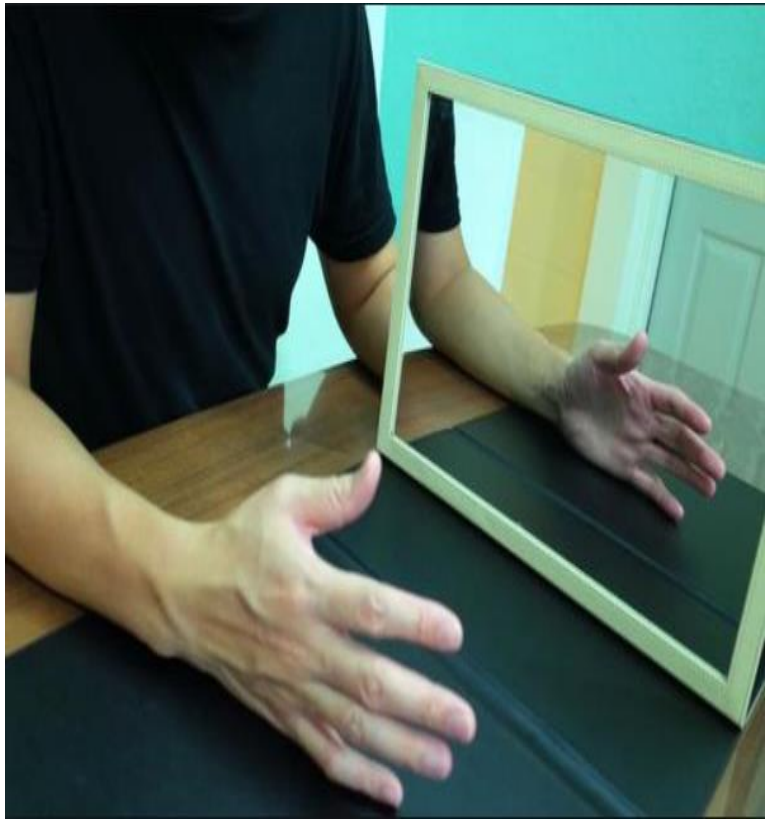


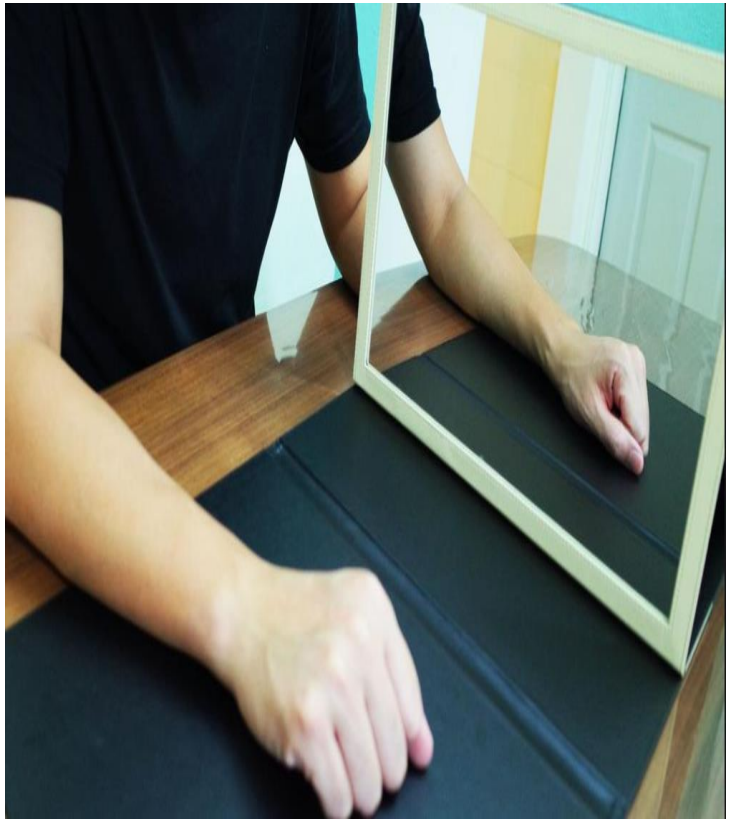
Mirror Therapy or Mirror Box Therapy[11,32,34]

- The use of mirror to create the suggestion of paretic upper limb movement when the non-paretic UL was repeatedly moved
- Hand movements requested during 10 minutes motor training:

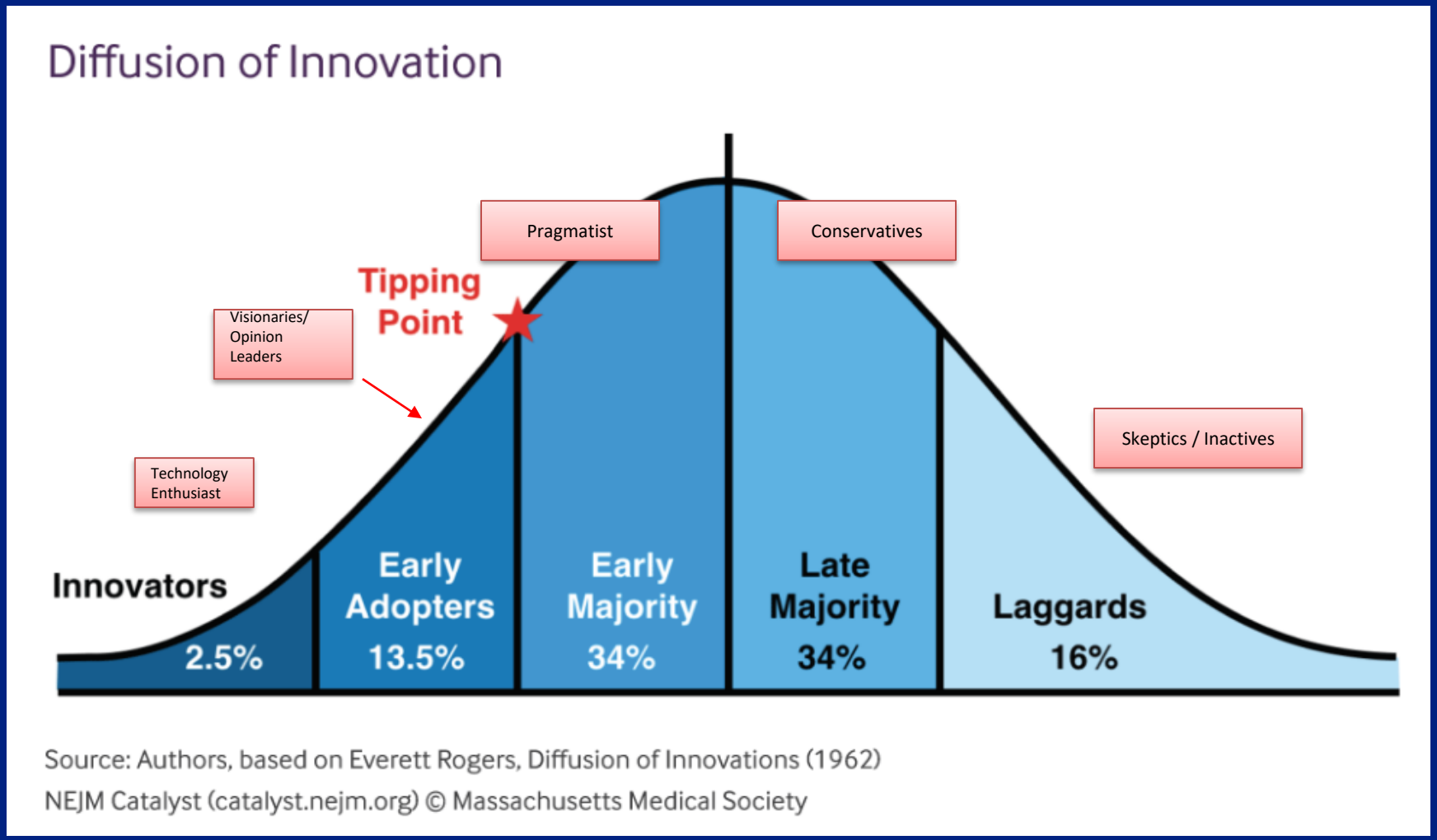
Hand movements	Duration
Opening/closing the hands	2 min
Whole hand tapping	2 min
Single finger tapping	2 min
Whole hand lateral rotation	2 min
Tapping of palm and back of the hand alternatively	2 min

Mirror Therapy





Technology Adoption Lifecycle



Summary / Key Points

- Hemiparesis following stroke is associated with significant upper extremity impairment, activity limitation, and reduced quality of life
- The first month post stroke represent a **critical window** for therapeutic interventions to maximize neurologic recovery of body functions & activities
- NMES has demonstrated sufficient level of evidence to recommend to use as an additional therapy to usual care to improve UE motor recovery
- mCIMT has sufficient level of evidence to recommend routine use
- Robotic therapy is reasonable to consider to deliver more intensive practice for individuals with moderate to severe UL paresis
- Mirror Box Therapy & SAEBO orthosis has insufficient level of evidence to support or refute routine use
- With shorter LOS & limited OP Therapy visits, therapists should engage & empower patients to be active participant in their recovery by educating & training them and their caregivers with home programs that are evidence based interventions

Any questions?

- Thank you

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