Recent Advances in the Field of Neuro-Rehab

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Objectives

- Provide a Brief Historical Review
- Discuss Advances in Neuro-Rehabilitation, highlighting interventions utilized throughout all phases of the rehab continuum (acute care/ICU, inpatient rehab setting, and outpatient)
- Explore emerging practices in Neuro-Rehabilitation
Historical Perspective

• **1926:** Warm Springs purchased by FDR, becoming the first comprehensive rehabilitation hospital

• **1941:** US enters WWII, broadening the focus of PM&R to include a comprehensive restoration of a patient’s capabilities as injured soldiers returned home. At that time...
  - Bed Rest was a prescribed standard of care for many conditions (Rheumatoid arthritis, back pain, Acute MI, Tuberculosis, etc.)
  - the 1st year Helmets became mandatory in NFL games (and CTE was referred to as “Punch-drunk syndrome”)

• **1990:** Americans with Disabilities Act (ADA) signed, which sought to insure:
  - equal opportunity
  - full participation in the community
  - Independent living
  - economic self-sufficiency
Current State of the Art

- Early Mobilization
- Neurostimulants
- Spasticity Management
- Functional E-Stim
- Robotics
- Prosthetics and Orthotics
Early Mobilization

- Bed rest known to contribute to increased mortality, skin breakdown, delirium, prolonged ICU/hospital stays, VAP, atelectasis, hemodynamic instability, muscle loss
- Loss of 1-2% of muscle mass daily
- Interventions: Early Mobility Team with implementation of a progressive mobility protocol, Exercise (sitting EOB, ambulation, ROM exercises), Education of Family, Cyclo-ergometers, EStim
- WellStar ICU Early Mobility program began in 2012
Early Mobilization

- Benefits:
  - fewer ventilator-dependent days/shortened ICU/hospital stays
  - reduced overall hospital cost and mortality
  - improved functional outcomes/proportion discharged home
  - decreased utilization of sedatives and IV pain medications
  - Decreased complications (blood clots, bloodstream infections, and skin breakdown)
  - Decreased prevalence of delirium/anxiety

- special considerations for NICU population:
  - hemiparesis/hemiplegia, cognitive impairment, variable intracerebral pressure and cerebral perfusion, cerebral monitoring devices
Neurostimulants

-goal: augment neuroplasticity following a brain insult
-neuroplasticity: process of developing new neuronal interconnections, acquiring new functions, and compensating for impairment
- facilitates neuro-recovery after brain injury, including other parts of the brain compensating for areas that have been damaged
- meaningful, repetitive, intensive, and task-specific movement training in an enriched environment promote neural plasticity and motor recovery
- Neurostimulants classes include SSRIs, dopamine agonists, NMDA receptor agonists, cholinergic agents
Neurostimulants

- SSRIs: Fluoxetine demonstrated evidence of enhanced recovery of motor deficits following ischemic CVA (FLAME trial, 2011)
- Methylphenidate: modulate dopamine/Norepinephrine levels. Attention, cognitive processing, arousal.
- Amantadine: modulates Dopamine. Attention and processing deficits.
- Bromocriptine: Dopamine Agonist. Low level, dysautonomia, vent weaning, aphasia.
- Modafinil: increases dopamine concentrations. General arousal.
- Namenda: NMDA receptor agonist. Aphasia.
- Aricept: increases acetylcholine concentrations. Aphasia.
Spasticity Management

- Spasticity: velocity dependent resistance to passive ROM (increase in tone)
- Long-term sequelae include: tendon contractures, limb deformities, significant pain and functional impairment.
- Impact mobility, ADLs, QOL, increased dependence
Spasticity Management

- Oral Agents: baclofen (GABA-B agonist), diazepam (GABA-A agonist), dantrolene (Ca+ release from skeletal muscle SR), and tizanidine (alpha-2 adrenergic agonist)
- Serial Casting
- Surgery Correction/Tendon lengthening
- Phenol Blocks/neurolytics
- Intrathecal Baclofen Pumps
- Botulinum toxin for Neuromuscular Blockade (Botox, Dysport, Xeomin)
- All interventions are only optimized when combined with therapy, bracing
Functional E-Stim

- most common utilization is foot drop (can supplant need for an orthotic)
- indicated for usage in re-training both the hand and leg (facilitating neuroplasticity)
- Stim delivered in precise sequence to activate the muscles facilitating gait
Robotics

- Advantages: Repeatability, precisely controllable assistance/resistance during movements, objective and quantifiable performance measures
- Provides intensive, task-oriented, repetitive training effective in promoting learning/neuroplasticity
- Improves proprioception
- WellStar Outpatient NeuroRehab Program the 1st in state to utilize UE robotic technology
Weight Supported Gait Training

- Enables repetitive practice of complex gait cycles
- Hemiparesis causes abnormal control of the paretic lower limb, resulting in an asymmetrical gait pattern
- Allows practice of nearly normal gait patterns (straighter trunk and knee alignment, improved swing time, stride length, walking speed), avoiding reinforcement of compensatory walking habits (hip hiking and circumduction)
- Facilitates reorganization at the spinal and supraspinal levels, reduces gait parameter asymmetries, and increases walking speed.
Exoskeletons

- automated robot-driven exoskeleton orthosis that simulate gait phases
- does not require a therapist to advance Limb or control weight shift
- requires sufficient UE function for balance/strength
- Weight: 50lbs
- Speed: 1mi/hr
- Cost: $60,000
Prosthetics & Orthotics

- Advances in material technologies and microprocessors have greatly expanded the capabilities of the field
- Carbon Fiber construction with energy storing properties
- Advancements with 3-D printing technology suggest potential for a future of affordable, quickly made orthotics/prosthetics
Emerging Trends Moving Forward

- Wearable technology
- Virtual Reality
- Smartphone/Tablet apps
- Non-Invasive Brain Stimulation Techniques (rTMS and tDCS)
- Brain-Machine Interface Technology
Emerging Trends

- Wearable technology:
  - Can Facilitate “Tele-medicine/tele-rehab”
  - Providers track movement outside of skilled therapies

- Virtual reality: repetitive, intensive, and task-specific
  - Promotes motor function improvements after stroke/TBI

- iPhone/iPad apps:
  - Facilitate training outside of skilled therapies
Brain-Machine Interface (BMI) Technology

- Allows control of a computer or other electronic devices using only brainwaves
- Can be used for communication, computer access or to control of devices (wheelchair and prosthetic arms)
Non-Invasive BrainStim Techniques

-NIBS: Repetitive Transcranial Magnetic Stimulation (rTMS) and transcranial direct current stimulation (tDCS)
  - can alter human cortex excitability
  - Aim to augment neural plasticity and improve motor function
  - Potential to improve motor function by increasing affected hemisphere excitability or decreasing unaffected hemisphere's
Questions?
Thanks.