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Upper Extremity Neurorehabilitation

Functional Electrical Stimulation

A large and continuously growing amount of evidence supports the utilization of functional electrical stimulation (FES) for individuals experiencing symptoms and a loss of upper extremity function due to a central nervous system condition. Much of that support is specific to the use of FES to address hemiparesis following a cerebrovascular accident (CVA) or spinal cord injury (SCI). The improvements shown in these, along with other studies, demonstrate that utilization of FES can significantly impact shoulder, arm, and hand function while improving quality of life.

Benefits of Upper Extremity FES found in the published research include:

Hand, Arm and Shoulder Function

- Increased grip strength and linear finger motion[1]
- Reduced severe hand impairment after short duration of NMES therapy[11]
- Greater functional benefit with NMES-assisted grasping than with traditional NMES of wrist flexors/extensors[11]
- Improved functional recovery of the upper extremity in ischemic stroke patients using interactive training with FES that enabled them to reach, grasp, move, place and release objects[2,6]
- Significantly higher scores on Wolf Motor Function Test (WMFT) following high-intensity FES-assisted exercise therapy; subacute stroke patients performing upper extremity workstation tasks[8]

Spasticity and Range of Motion (ROM)

- Decreased spasticity[13]
- Increased ROM[6,13]

Neuroplasticity

- Improved reaching movements in patients with motor impairment of the upper limb[3,4]

Quality of Life (QOL) and Independent Function

- Decreased simulated feeding time[2]
- Decreased pain[3]
- Improved performance of ADL[7]

Robust evidence supports the use of FES as a safe, non-invasive treatment to facilitate motor learning and the recovery of function in individuals affected by CNS injury or disease (Popovic, Kurt, Keller & Deitz, 2001; Alon & McBride, 2003; Cuest-Gomez, et al, 2017). Daly & Ruff (2007) noted that "activity-dependent CNS plasticity and the requisite motor learning principles can be used to construct an efficacious motor recovery intervention" for individuals following injury or damage to their central nervous system. For those with upper extremity dysfunction, the key is performing the motor behavior as well as coordination and strengthening exercises with functional training to promote motor learning. Research supports that functional recovery is improved when used in conjunction with FES for task-specific, interactive training (Santos, Zahner, McKeirnan & Quaney, 2006; Alon, Levitt, & McCarthy, 2007; Chae, Sheffler & Knutson, 2008). With the assistance of FES, individuals having mild to significant involvement are still able to perform motor tasks that they may otherwise be unable to perform independently, thereby allowing them to practice more normal movements

(Alon, et al, 2007; Daly, et al, 2005; Popovic, et al, 2003). Application of FES with a wrist-hand orthosis may contribute to neutral positioning of the wrist and subsequent opening of the fingers in an attempt to create a functional open hand (van Klink, Dewald, Sullivan & Yao, 2013). FES is an efficient and effective tool that affects pain, spasticity, weakness, and incoordination contributing to functional limitations. At the same time it retrains the brain and body, promoting recovery of normal movement patterns. Each of these significant benefits may contribute to independent function an enhanced quality of life. Systematic reviews and meta-analyses have shown that NMES combined with other treatment modalities can improve spasticity and range of motion in patients after stroke (Stein, Fritsch, Robinson, Sbruzzi & Plentz, 2015) and FES is a promising therapy which could be utilized in future stroke rehabilitation (Daly, et al, 2005; Eraifej, Clark, France, Desando & Moore, 2017).

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