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Reach for the Stars: Improving Upper Extremity Function After Spinal Cord Injury

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Presented in Partial Fulfillment of the Master of Science in Occupational Therapy degree at Thomas Jefferson University

Objectives of Presentation:

1.) **Describe** how cervical spinal cord injury affects UE functioning necessary for activities of daily living.
2.) **Describe** occupational therapy interventions used to increase UE functioning in cervical SCI.
3.) **Discuss** how current evidence supports implementing occupational therapy interventions into clinical practice for individuals with cervical SCI, in order to maximize independence in activities of daily living.

PICO: What is the evidence supporting occupational therapy interventions to increase upper extremity function in order to improve ADL performance following Cervical Spinal Cord Injury?

Methods

Databases: CINAHL, OT Seeker, PubMed

Search Terms:Spinal cord injury [mesh], spinal cord injuries [mesh], quadriplegia [mesh], adult [mesh], young adult [mesh], spinal cord injur*, tetraplegia,Occupational therapy [mesh], occupational therap*, therapy, electrical stimulation, motor learning principles,Activity of daily living, activity of daily living performance, independence, hand function*, upper extremity function*

Inclusion Criteria	**Exclusion Criteria**
-2005-present -English language -15+ years of age -Male and Female -History of Spinal Cord Injury -Quadriplegia/Tetraplegia -ASIA levels A, B, C, D -Inpatient and Outpatient Services	-Animal Research -Systematic Reviews, Literature Reviews, Expert Opinions -History of cerebrovascular accident (CVA) or -Traumatic Brain Injury (TBI) -Paraplegia -Surgical Interventions (ex. tendon transfers) Pain as outcome measure

Critique
-2 researchers reviewed each article using: Evaluation of Quality of an Intervention Study: Law, M. & McDermid, J. (2003). Appendix M and N (pp 414-423). In *Evidence-Based Rehabilitation*. Thorofare, NJ: Slack, Inc.

Identified 617 articles through database searching with duplicates removed
14 articles included in quantitative synthesis

Results

Theme 1: Functional Electrical Stimulation (FES)[7,8,10,14,18]	**Theme 2: Neuroprosthesis/ Neuromuscular Electrical Stimulation-assisted grasp[11,15,18]**	**Theme 3: Robotic Training[3,21,22]**	**Theme 4: Massed Practice and Somatosensory Stimulation[2,5,6]**
-**Moderate evidence** supports the inclusion of FES for best practice in providing occupational therapy services for individuals with Cervical Spinal Cord Injury -**5/5** articles (Level I, Level III, and Level IV) reported outcomes in favor of FES as effective intervention for improving hand function -**3/5** articles included statistical analyses	-**Limited** evidence supports the use of neuroprostheses/ NMES -**3/3** studies included statistical analyses **2/3** studies showed statistically significant results **immediately** after intervention [11,18]	-**Limited** evidence to support the use of robotic training -**2/3** found significant improvements after intervention -**3/3** studies reported functional improvements	-**Moderate evidence** to support combining massed practice and somatosensory stimulation as an intervention approach -**3/3** studies found significant improvements after intervention -**2/3** studies included statistical analyses -**1/3** studies reported functional improvements

For further questions and information, please contact: Blair.Krevitz@gmail.com

(1) American Occupational Therapy Association. (2014). Occupational therapy practice framework: Domain and process (3rd ed.).

American Journal of Occupational Therapy, 68(Suppl. 1).

(2) Beekhuizen, K., & Field-Fote, E. (2008). Sensory stimulation augments the effects of massed practice training in persons with tetraplegia. *Archives of Physical Medicine and Rehabilitation, 89* (4), 602-608. doi:10.1016/j.apmr.2007.11.021.

(3) Cortes, M., Elder, J., Rykman, A., Murray, L., Avedissian, M., Stampa, A., ... & Edwards, D. J. (2013). Improved motor performance in chronic spinal cord injury following upper-limb robotic training. *NeuroRehabilitation*, *33*(1), 57-65.

(4) Foy, T., Perritt, G., Thimmaiah, D., Heisler, L., Offutt, J. L., Cantoni, K., … & Backus, D. (2011). Occupational therapy treatment time during inpatient spinal cord injury rehabilitation. *The Journal of Spinal Cord Medicine*, *34*(2), 162–175. doi:10.1179/107902611X12971826988093

(5) Hoffman, L., & Field-Fote, E. (2007). Cortical reorganization following bimanual training and somatosensory stimulation in cervical spinal cord injury: A case report. *Journal of the American Physical Therapy Association, 87*(2), 208-223. doi: 10.2522/ptj.20050365.

(6)Hoffman, L. & Field-Fote, E. (2010). Functional and corticomotor changes in individuals with tetraplegia following unimanual or bimanual massed practice training with somatosensory stimulation: A pilot study. *Journal of Neurologic Physical Therapy, 34*(4), 193-201. doi: 10.1097/NPT.0b013e3181fbe692

(7) Kapadia, N. M., Bagher, S., & Popovic, M. R. (2014). Influence of different rehabilitation therapy models on patient outcomes: Hand function therapy in individuals with incomplete SCI. *The Journal of Spinal Cord Medicine, 37*(6), 734-743. doi:10.1179/2045772314Y.0000000203

(8) Kapadia, N., Zivanovic, V., & Popovic, M., R. (2013). Restoring voluntary grasping function in individuals with incomplete chronic spinal cord injury: Pilot study. *Topics in Spinal Cord Injury Rehabilitation,19*(4), 279-287. doi:10.1310/sci1904-279

(9) Kirshblum, S. C., Burns, S. P., Biering-Sorensen, F., Donovan, W., Graves, D. E., Jha, A., … Waring, W. (2011). International standards for neurological classification of spinal cord injury (Revised 2011). *The Journal of Spinal Cord Medicine, 34*(6), 535–546. doi:10.1179/204577211X13207446293695

(10) Mangold, S., Keller, T., Curt A., & Dietz, V. (2005). Transcutaneous functional electrical stimulation for grasping in subjects with cervical spinal cord injury. *Spinal Cord, 43,* 1-13.

(11) Martin, R., Johnston, K., & Sadowsky, C. (2012). Brief report—Neuromuscular electrical stimulation–assisted grasp training and restoration of function in the tetraplegic hand: A case series. *American Journal of Occupational Therapy, 66,* 471–477. doi: http://dx.doi.org/10.5014/ajot.2012.003004

(12) Memberg, W. D., & Crago, P. E. (2000). An analysis of the input-output properties of neuroprosthetic hand grasps. *Journal of rehabilitation research and development*, *37*(1), 11-22.

(13) Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *PLoS Med, 6*(7). doi: 10.1371/journal.pubmed.1000097

(14) Popovic, M.R., Kapadia, N., Zivanovic, V., Furlan, J.C., Craven, C., McGillivray, C.(2011). Functional electrical stimulation therapy of voluntary grasping versus only conventional rehabilitation for patients with subacute incomplete tetraplegia: A randomized clinical trial. *Neurorehabilitation and Neural Repair, 25*(5), 433-442. doi: 10.1177/1545968310392924

(15) Rupp, R., Kreilinger, A., Rohm, M., Kaiser, V., & Muller-Putz, G. R. (2012). Development of a non-invasive, multifunctional grasp neuroprosthesis and its evaluation in an individual with a high spinal cord injury. Conference Proceedings : ...Annual International Conference of the IEEE Engineering in Medicine and Biology Society. IEEE Engineering in Medicine and Biology Society.Annual Conference,2012, 1835-1838. doi:10.1109/EMBC.2012.6346308

(16) Spinal Cord Injury (SCI) Facts and Figures at a Glance. (2015, February). Retrieved July 10, 2015, from https://www.nscisc.uab.edu/Public/Facts 2015.pdf

(17) Thorsen, R., Costa, D. D., Chiaramonte, S., Binda, L., Beghi, E., Redaelli, T., Occhi, E., Ferrarin, M. (2013). A noninvasive neuroprosthesis augments hand grasp force in individuals with cervical spinal cord injury: the functional and therapeutic effects. *The Scientific World Journal*. doi: 10.1155/2013/836959

(18) Thorsen, R., Occhi, E. Boccardi, S., Ferrarin, M. (2006). Functional electrical stimulation reinforced tenodesis effect controlled by myoelectric activity from wrist extensors. *Journal of Rehabilitation Research & Development, 43*(2), 247-256.

(19) Whiteneck, G., Gassaway, J., Dijkers, M., Backus, D., Charlifue, S., Chen, D., … Smout, R. J. (2011). Inpatient treatment time across disciplines in spinal cord injury rehabilitation. *The Journal of Spinal Cord Medicine, 34*(2), 133–148. doi:10.1179/107902611X12971826988011

(20) Yozbatiran, N., Berliner, J., O'Malley, M. K., Pehlivan, A. U., Kadivar, Z., Boake, C., & Francisco, G. E. (2012). Robotic training and clinical assessment of upper extremity movements after spinal cord injury: a single case report. *Journal of rehabilitation medicine*, *44*(2), 186-188.

(21) Zariffa, J., Kapadia, N., Kramer, J. L., Taylor, P., Alizadeh-Meghrazi, M., Zivanovic, V., Willms, R., Townson, A., Curt, A., Popovic, M. R., Steeves, J. D. (2011). Feasibility and efficacy of upper limb robotic rehabilitation in a subacute cervical spinal cord injury population. *Spinal Cord, 50*(3), 220-226. doi: 10.1038/sc.2011.