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I B I T A

Literature Abstracts 2010/1 compiled by the Education Committee of IBITA

(Susan Ryerson)

The effect of arm movements on the lower limb during gait after a stroke. Stephenson JL, De Serres SJ, Lamontagne A. Gait Posture. 2010 Jan;31(1):109-15. Epub 2009 Oct 24

The purpose of this study was to examine the influence of arm movements on lower limb movement and muscle activation during treadmill walking after a stroke. Ten high functioning stroke and 10 healthy subjects walked on a treadmill while swinging their arms naturally, and while holding onto handles that were either fixed in place or allowed to slide along horizontal handrails. Full-body kinematics were recorded, along with bilateral surface electromyography from lower limb muscles. Arm movements influenced lower limb muscle activity but had little effect on movement patterns at the joints. When handrails were present a small amount of weight was borne through the upper limbs, and for stroke subjects this was reduced when the handles were free to slide. Activity of proximal leg muscles during stance was affected by the weight borne through the upper limbs, increasing when arm movements were performed. Soleus activity during stance was greatest with unsupported arm movements. In stroke subjects, early stance tibialis anterior activity in the paretic leg was greatest with no arm movements, and early swing tibialis anterior activity in both legs was greatest with unsupported arm movements. Many of the changes in muscle activation appeared to be due to changes in postural stability that occurred when performing arm movements. Overall, results support further study of the long-term changes associated with the inclusion of arm movements in gait rehabilitation protocols.

Locomotor Training Improves Daily Stepping Activity and Gait Efficiency in Individuals Poststroke Who Have Reached a "Plateau" in Recovery. Moore J, Roth EJ, Killian C, Hornby G. Stroke. 2010;41:129-135.

Background and Purpose: Individuals with chronic stroke often demonstrate a "plateau," or deceleration of motor recovery, which may lead to discharge from physical therapy (PT). However, numerous studies report improvements in motor function when individuals are provided intensive practice of motor tasks. We suggest that reduced task-specific walking practice during clinical PT contributes to limited gains in ambulatory function in those with a perceived plateau poststroke, and suggest that further gains can be realized if intensive stepping, or locomotor training (LT) is provided after discharge. *Methods*: Twenty subjects with chronic stroke completed a repeated baseline measures, randomized crossover trial in which walking performance was assessed during the last 4 weeks of clinical PT before discharge secondary to reaching a plateau, followed by 4 weeks of intensive LT and 4 weeks of no intervention. Outcome measures included clinical and physiological (metabolic) measures of walking over ground and on a treadmill, and measures of daily stepping activity in the home and community, including during clinical PT and subsequent LT sessions. *Results*: Stepping practice was more than 4-fold higher during LT versus clinical PT sessions, with significant improvements in daily stepping and gait efficiency only after LT. Changes in daily stepping after clinical PT and intensive LT were correlated ($P<0.001$) with the amount of stepping practice received during these interventions. *Conclusions*: Intensive LT results in improved daily stepping in individuals poststroke who have been discharged from PT because of a perceived plateau in motor function. These improvements may be related to the amount and intensity of stepping practice.

5-repetition sit-to-stand test in subjects with chronic stroke: reliability and validity. Mong Y, Teo TW, Ng SS. Arch Phys Med Rehabil. 2010 Mar;91(3):407-13.,

OBJECTIVES: To examine the (1) intrarater, interrater, and test-retest reliability of the 5-repetition sit-to-stand test (5-repetition STS test) scores, (2) correlation of 5-repetition STS test scores with lower-limb muscle strength and balance performance, and (3) cut-off scores among the 3 groups of subjects: the young, the healthy elderly, and subjects with stroke. DESIGN: Cross-sectional study. SETTING: University-based rehabilitation center. PARTICIPANTS: A convenience sample of 36 subjects: 12 subjects with chronic stroke, 12 healthy elderly subjects, and 12 young subjects. INTERVENTIONS: Not applicable. MAIN OUTCOME MEASURES: 5-Repetition STS test time scores; hand-held dynamometer measurements of hip flexors, and knee flexors and extensors; ankle dorsiflexors and plantarflexors muscle strength; Berg Balance Scale (BBS); and limits of stability (LOS) test using dynamic posturography. RESULTS: Excellent intrarater reliability of intraclass correlation coefficient (ICC) (range, .970-.976), interrater reliability (ICC=.999), and test-retest reliability (ICC range, .989-.999) were found. Five-repetition STS test scores were also found to be significantly associated with the muscle strength of affected and unaffected knee flexors (rho=-.753 to -.830; P<.00556) of the subjects with stroke. No significant associations were found between 5-repetition STS test and BBS and LOS tests in subjects with stroke. Cut-off scores of 12 seconds were found to be discriminatory between healthy elderly and subjects with stroke at a sensitivity of 83% and specificity of 75%. CONCLUSIONS: The 5-repetition STS test is a reliable measurement tool that correlates with knee flexors muscle strength but not balance ability in subjects with stroke.

A systematic review of the therapeutic interventions for heterotopic ossification after spinal cord injury. Teasell RW, Mehta S, Aubut JL, Ashe MC, Sequeira K, Macaluso S, Tu L. Spinal Cord. 2010 Jan 5. [Epub ahead of print]

Study design: Systematic review. *Objective*: To conduct a systematic review of the effectiveness of interventions used to prevent and treat heterotopic ossification (HO) after spinal cord injury (SCI). *Setting*: St Joseph's Parkwood Hospital, London, Ontario, Canada. *Methods*: MEDLINE, CINAHL, EMBASE and PsycINFO databases were searched for articles addressing the treatment of HO after SCI. Studies were selected by two reviewers and were only included for analysis if at least 50% of the subjects had an SCI, there were at least three SCI subjects and if the study subjects participated in a treatment or intervention. Study quality was assessed by two independent reviewers using the Downs and Black evaluation tool for all studies, as well as the PEDro assessment scale for randomized control trials only. Levels of evidence were assigned using a modified Sackett scale. Results:A total of 13 studies met the inclusion criteria. The selected articles were divided into prevention or treatment of post-SCI HO. Nonsteroidal anti-inflammatory drugs (NSAIDs), warfarin, and pulse low-intensity electrogmagnetic field (PLIMF) therapy were reviewed as prophylactic measures. Bisphosphonates, radiotherapy and excision were reviewed as treatments of post-SCI HO. *Conclusions*: Pharmacological treatments of HO after SCI had the highest level of research evidence supporting their use. Of these, NSAIDs showed greatest efficacy in the prevention of HO when administered early after an SCI, whereas bisphosphonates were the intervention with strongest supportive evidence once HO had developed. Of the non-pharmacological interventions, PLIMF was supported by the highest level of evidence; however, more research is needed to fully understand its role.

Neurogenic bowel management after spinal cord injury: a systematic review of the evidence. Krassioukov A, Eng JJ, Claxton G, Sakakibara BM, Shum S. Spinal Cord. 2010 Mar 9

Study design: Randomized-controlled trials (RCTs), prospective cohort, case-control, pre-post studies, and case reports that assessed pharmacological and non-pharmacological intervention for the management of the neurogenic bowel after spinal cord injury (SCI) were included. *Objective*: To systematically review the evidence for the management of neurogenic bowel in individuals with SCI. *Setting*: Literature searches were conducted for relevant articles, as well as practice guidelines, using

numerous electronic databases. Manual searches of retrieved articles from 1950 to July 2009 were also conducted to identify literature. *Methods*: Two independent reviewers evaluated each study's quality, using Physiotherapy Evidence Database scale for RCTs and Downs and Black scale for all other studies. The results were tabulated and levels of evidence assigned. *Results*: A total of 2956 studies were found as a result of the literature search. On review of the titles and abstracts, 57 studies met the inclusion criteria. Multifaceted programs are the first approach to neurogenic bowel and are supported by lower levels of evidence. Of the non-pharmacological (conservative and non-surgical) interventions, transanal irrigation is a promising treatment to reduce constipation and fecal incontinence. When conservative management is not effective, pharmacological interventions (for example prokinetic agents) are supported by strong evidence for the treatment of chronic constipation. When conservative and pharmacological treatments are not effective, surgical interventions may be considered and are supported by lower levels of evidence in reducing complications. *Conclusions*: Often, more than one procedure is necessary to develop an effective bowel routine. Evidence is low for non-pharmacological approaches and high for pharmacological interventions.

Role of the primary somatosensory cortex in motor learning: An rTMS study. Vidoni ED, Acerra NE, Dao E, Meehan SK, Boyd LA. Neurobiol Learn Mem. 2010 Feb 2.

Somatosensation is thought to play an important role in skilled motor learning. The present study investigated how healthy adults learn a continuous implicit motor task when somatosensation is altered by 1Hz repetitive transcranial magnetic stimulation (rTMS) delivered over the primary somatosensory cortex (S1). Twenty-seven right-handed participants enrolled in a two-part experiment. In Experiment 1, we verified that 20min of 1Hz rTMS over S1 disrupted cutaneous somatosensation (indexed by two-point discrimination) in the wrist/hand; the impact of 1Hz rTMS on wrist proprioception (tested by limb-position matching) was variable. Sham rTMS had no effect on either measure. We exploited these effects in Experiment 2 by pairing either 1Hz or sham rTMS with practice of a continuous tracking task over two separate sessions on different days. Implicit motor learning was indexed on a third, separate retention test day when no rTMS was delivered. Across practice in Experiment 2, both the 1Hz and sham rTMS groups showed improved tracking performance; however, 1Hz rTMS was associated with less accurate tracking and smaller improvements in performance. Importantly, at the no rTMS retention test the effects of altering sensation with stimulation over S1 were still evident in the persistently less accurate tracking behavior of the 1Hz rTMS group. The current study shows that disruption of somatosensation during task practice impairs the magnitude of change associated with motor learning, perhaps through the development of an inaccurate internal model.

Backward walking in Parkinson's disease. Hackney ME, Earhart GM. Mov Disord. 2009 Jan 30;24(2):218-23.

We walk backward on a daily basis, such as when backing away from the kitchen sink or stepping back from a curb as a swiftly moving bus passes. This task may be particularly difficult for individuals with Parkinson's disease (PD) who often fall as a result of moving or being perturbed in the backward direction. The aim of this study was to assess backward walking (BW) in individuals with PD. Both forward walking (FW) and BW were assessed in 78 people with idiopathic PD (H&Y range: 0.5-3) in the ON state, and 74 age- and sex-matched controls. In FW, those with PD had significantly shorter strides, lower swing percents, higher stance percents, and lower functional ambulation profiles than controls. Both groups walked significantly slower and with a wider base of support during BW than FW. Additionally, in BW those with PD walked significantly slower with shorter strides, lower swing percents, and higher double support and stance percents, and lower functional ambulation profiles compared with controls. Those with mild to moderate PD have impaired FW and BW, but differences between those with and without PD are more pronounced in BW.

Four-week trunk-specific rehabilitation treatment improves lateral trunk flexion in Parkinson's disease. Bartolo M, Serrao M, Tassorelli C, Don R, Ranavolo A, Draicchio F, Pacchetti C, Buscone S, Perrotta A, Furnari A, Bramanti P, Padua L, Pierelli F, Sandrini G. Mov Disord. 2010 Feb 15;25(3):325-31.

People with Parkinson's disease (PD) often have a posture characterized by lateral trunk flexion poorly responsive to antiparkinsonian drugs. To examine the effects of a rehabilitation programme (daily individual 90-minute-sessions, 5-days-a-week for 4-consecutive weeks) on lateral trunk flexion and mobility, 22 PD patients with mild to severe lateral trunk flexion, and 22 PD patients without trunk flexion were studied. Patients were evaluated using the Unified Parkinson's Disease Rating Scale motor subscale (UPDRS-III) score, and the kinematic behavior of the trunk was recorded by means of an optoelectronic system to determine: a) trunk flexion, inclination and rotation values in the erect standing posture; b) ranges of trunk flexion and inclination during trunk movements. After the treatment, significant decreases in trunk flexion [24 degrees (4) vs. 14 degrees (3), $P < 0.001$] and inclination in the static condition [23 degrees (5) vs. 12 degrees (4), $P < 0.001$)] were observed, both of which were maintained at the 6-month follow up. During the trunk flexion task, a significantly increased range of trunk flexion [64 degrees (15) vs. 83 degrees (15), $P < 0.001$] was observed; similarly, during the lateral bending task, the range of trunk inclination was found to be significantly increased, both toward the side of the trunk deviation [29 degrees (8) vs. 42 degrees (13), $P < 0.01$] and toward the contralateral side [14 degrees (6) vs 29 degrees (11), $P < 0.01$]. No further significant changes were observed at the 6-month follow-up. Trunk flexion and inclination values in the upright standing posture correlated slightly with the UPDRS-III score. Our findings show that significant improvements in axial posture and trunk mobility can be obtained through the 4-week rehabilitation programme described, with a parallel improvement in clinical status.

Fatigue, mood and quality of life improve in MS patients after progressive resistance training. Dalgas U, Stenager E, Jakobsen J, Petersen T, Hansen H, Knudsen C, Overgaard K, Ingemann-Hansen T. Mult Scler. 2010 Mar 1. [Epub ahead of print]

Fatigue occurs in the majority of multiple sclerosis patients and therapeutic possibilities are few. Fatigue, mood and quality of life were studied in patients with multiple sclerosis following progressive resistance training leading to improvement of muscular strength and functional capacity. Fatigue (Fatigue Severity Scale, FSS), mood (Major Depression Inventory, MDI) and quality of life (physical and mental component scores, PCS and MCS, of SF36) were scored at start, end and follow-up of a randomized controlled clinical trial of 12 weeks of progressive resistance training in moderately disabled (Expanded Disability Status Scale, EDSS: 3-5.5) multiple sclerosis patients including a Control group (n = 15) and an Exercise group (n = 16). Fatigue (FSS > 4) was present in all patients. Scores of FSS, MDI, PCS-SF36 and MCS-SF36 were comparable at start of study in the two groups. Fatigue improved during exercise by -0.6 (95% confidence interval (CI) -1.4 to 0.4) a.u. vs. 0.1 (95% CI -0.4 to 0.6) a.u. in controls ($p = 0.04$), mood improved by -2.4 (95% CI -4.1 to 0.7) a.u. vs. 1.1 (-1.2 to 3.4) a.u. in controls ($p = 0.01$) and quality of life (PCS-SF36) improved by 3.5 (95% CI 1.4-5.7) a.u. vs. -1.0 (95% CI -3.4-1.4) a.u. in controls ($p = 0.01$). The beneficial effect of progressive resistance training on all scores was maintained at follow-up after further 12 weeks. Fatigue, mood and quality of life all improved following progressive resistance training, the beneficial effect being maintained for at least 12 weeks after end of intervention.

Long-Term TENS Treatment Improves Tactile Sensitivity in MS Patients. Cuypers K, Levin O, Thijs H, Swinnen SP, Meesen RL.Neurorehabil Neural Repair. 2010 Jan 19. [Epub ahead of print]

BACKGROUND: Transcutaneous electrical nerve stimulation (TENS) is commonly used in neurorehabilitation for the treatment of pain and spasticity. OBJECTIVE: The long-term effects of sensory stimulation by means of TENS on hand sensitivity were investigated in patients with multiple sclerosis (MS). METHODS: TENS was applied for 3 weeks (1 hour per day) on the median nerve region

of the dominant hand. Sensitivity was assessed by the Semmes-Weinstein monofilaments before and 12 hours following the last intervention as well as 3 weeks later. RESULTS: Long-lasting increases in tactile sensitivity were achieved by repetitive stimulation of sensory afferents with TENS in MS patients but not in healthy subjects. This increased sensitivity was not only restricted to the median nerve area but also expanded to the ulnar nerve area. Remarkably, MS patients reached the same level of sensitivity as healthy subjects immediately after the intervention, and long-term effects were reported 3 weeks later. CONCLUSIONS: The findings of this study demonstrated lasting improvements in tactile sensitivity of the fingers as a result of a long-term TENS intervention in MS patients, who ultimately reached a level comparable with that of healthy subjects.

Transfer of Dynamic Learning Across Postures. Ahmed A, Wolpert DM. J Neurophysiol 102: 2816-2824, 2009

When learning a difficult motor task, we often decompose the task so that the control of individual body segments is practiced in isolation. But on re-composition, the combined movements can result in novel and possibly complex internal forces between the body segments that were not experienced (or did not need to be compensated for) during isolated practice. Here we investigate whether dynamics learned in isolation by one part of the body can be used by other parts of the body to immediately predict and compensate for novel forces between body segments. Subjects reached to targets while holding the handle of a robotic, force-generating manipulandum. One group of subjects was initially exposed to the novel robot dynamics while seated and was then tested in a standing position. A second group was tested in the reverse order: standing then sitting. Both groups adapted their arm dynamics to the novel environment, and this movement learning transferred between seated and standing postures and vice versa. Both groups also generated anticipatory postural adjustments when standing and exposed to the force field for several trials. In the group that had learned the dynamics while seated, the appropriate postural adjustments were observed on the very first reach on standing. These results suggest that the CNS can immediately anticipate the effect of learned movement dynamics on a novel whole-body posture. The results support the existence of separate mappings for posture and movement, which encode similar dynamics but can be adapted independently.

The Balance Evaluation Systems Test (BESTest) to Differentiate Balance Deficits. Horak FB, Wrisley,DM, Frank J. 2009. Phys Ther 89;484-498.

Background: Current clinical balance assessment tools do not aim to help therapists identify the underlying postural control systems responsible for poor functional balance. By identifying the disordered systems underlying balance control, therapists can direct specific types of intervention for different types of balance problems. *Objective*: The goal of this study was to develop a clinical balance assessment tool that aims to target 6 different balance control systems so that specific rehabilitation approaches can be designed for different balance deficits. This article presents the theoretical framework, interrater reliability, and preliminary concurrent validity for this new instrument, the Balance Evaluation Systems Test (BESTest). *Design*: The BESTest consists of 36 items, grouped into 6 systems: "Biomechanical Constraints," "Stability Limits/Verticality," "Anticipatory Postural Adjustments," "Postural Responses," "Sensory Orientation," and "Stability in Gait." Methods: In 2 interrater trials, 22 subjects with and without balance disorders, ranging in age from 50 to 88 years, were rated concurrently on the BESTest by 19 therapists, students, and balance researchers. Concurrent validity was measured by correlation between the BESTest and balance confidence, as assessed with the Activities-specific Balance Confidence (ABC) Scale. *Results:* Consistent with our theoretical framework, subjects with different diagnoses scored poorly on different sections of the BESTest. The intraclass correlation coefficient (ICC) for interrater reliability for the test as a whole was .91, with the 6 section ICCs ranging from .79 to .96. The Kendall coefficient of concordance among raters ranged from .46 to 1.00 for the 36 individual items. Concurrent validity of the correlation between the BESTest and the ABC Scale was r=.636, P<.01. *Limitations:* Further testing is needed to determine whether: (1) the sections of the BESTest actually detect independent balance deficits, (2) other systems important for

balance control should be added, and (3) a shorter version of the test is possible by eliminating redundant or insensitive items. *Conclusions:* The BESTest is easy to learn to administer, with excellent reliability and very good validity. It is unique in allowing clinicians to determine the type of balance problems to direct specific treatments for their patients. By organizing clinical balance test items already in use, combined with new items not currently available, the BESTest is the most comprehensive clinical balance tool available and warrants further development.

Your mind's hand: motor imagery of pointing movements with different accuracy. Lorey B, Pilgramm S, Walter B, Stark R, Munzert J, Zentgraf K.Neuroimage. 2010 Feb 15;49(4):3239-47. Epub 2009 Dec 4.

Jeannerod (2001) postulated that motor control and motor simulation states are functionally equivalent. If this is the case, the specifically relevant task parameters in online motor control should also be represented in motor imagery. We tested whether the different spatial accuracy demands of manual pointing movements are reflected on a neural level in motor imagery. During functional magnetic resonance imaging (fMRI) scanning, 23 participants imagined hand movements that differed systematically in terms of pointing accuracy needs (i.e., none, low, high). In a low-accuracy condition, two big squares were presented visually prior to the imagery phase. These squares had to be pointed at alternately on a mental level. In the high-accuracy condition, two little squares had to be hit. As expected on the basis of speed-accuracy trade-off principles, results showed that participants required more time when accuracy of the imagined movements increased. The fMRI results showed a stepwise increase in activation in the anterior cerebellum and the anterior part of the superior parietal lobe (SPL) with rising accuracy needs. Moreover, we found increased activation of the anterior part of the SPL and of the dorsal premotor cortex (dPMC) when imagery included a square (i.e., in the low- and high-accuracy conditions) compared to the no-square condition. These areas have also been discussed in relation to online motor control, suggesting that specific task parameters relevant in the domain of motor control are also coded in motor imagery. We suggest that the functional equivalence of action states is due mostly to internal estimations of the expected sensory feedback in both motor control and motor imagery.