



Clinical Data:
Evidence Based EMST Outcomes

EMSTTM 150
EXPIRATORY MUSCLE STRENGTH TRAINER

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Respiratory training in an individual with amyotrophic lateral sclerosis

Lauren C. Tabor, Karen M. Rosado, Raele Robison, Karen Hegland, Vanessa A. Humbert, and Emily K. Plowman.

Abstract. We examined the impact of expiratory muscle strength training on maximum expiratory pressure, cough spirometry, and disease progression in a 71-year-old male with amyotrophic lateral sclerosis. Maximum expiratory pressure declined 9% over an 8-week sham training period, but subsequently improved by 102% following 8 weeks of expiratory muscle strength training. Improvements in cough spirometry and mitigated disease progression were also observed post expiratory muscle strength training. Improvements in maximum expiratory pressures were maintained 6 months following expiratory muscle strength training and were 79% higher than baseline data obtained 301 days prior. In this spinal-onset amyotrophic lateral sclerosis patient, respiratory training improved subglottic air pressure generation and sequential cough generation.

Muscle Nerve. 2016 June ; 54(1): 48–53. doi:10.1002/mus.24990.

Impact of Expiratory Strength Training in Amyotrophic Lateral Sclerosis

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Abstract

Introduction—We evaluated the feasibility and impact of Expiratory Muscle Strength Training (EMST) on respiratory and bulbar function in persons with amyotrophic lateral sclerosis (ALS).

Methods—25 ALS patients participated in this delayed intervention open-label clinical trial. Following a lead-in period, patients completed a 5-week EMST protocol. Outcome measures included: maximum expiratory pressure (MEP), physiologic measures of swallow and cough, and Penetration-Aspiration Scale (PAS) scores.

Results—Of those participants who entered the active phase of the study (n=15), EMST was well tolerated and led to significant increases in MEPs and maximum hyoid displacement during swallowing post-EMST (P <0.05). No significant differences were observed for PAS scores or cough spirometry measures. **Discussion**—EMST was feasible and well tolerated in this small cohort of ALS patients and led to improvements in expiratory force-generating pressures and swallow kinematics. Further investigation is warranted to confirm these preliminary findings.

Keywords

Amyotrophic Lateral Sclerosis; Rehabilitation; Respiratory Training; Expiratory Muscle Strength Training; Swallowing

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Arch Phys Med Rehabil. 2016 Aug;97(8):1345-51.

Rehabilitation of Swallowing and Cough Functions Following Stroke: An Expiratory Muscle Strength Training Trial

Karen Wheeler Hegland, PhD, CCC-SLP, , Paul W. Davenport, PhD, Alexandra E. Brandimore, PhD, CCC-SLP, Floris F. Singletary, MS, CCC-SLPd, Michelle S. Troche, PhD, CCC-SLP

Abstract. To determine the effect of expiratory muscle strength training (EMST) on both cough and swallow function in stroke patients. Prospective pre-post intervention trial with 1 participant group. Two outpatient rehabilitation clinics. Adults (N=14) with a history of ischemic stroke in the preceding 3 to 24 months. EMST. The training program was completed at home and consisted of 25 repetitions per day, 5 days per week, for 5 weeks. Baseline and post training measures were maximum expiratory pressure, voluntary cough airflows, reflex cough challenge to 200 μ mol/L of capsaicin, sensory perception of urge to cough, and fluoroscopic swallow evaluation. Repeated measures and 1-way analyses of variance were used to determine significant differences pre- and post training. **Maximum expiratory pressure increased in all participants by an average of 30cmH₂O post training.** At baseline, all participants demonstrated a blunted reflex cough response to 200 μ mol/L of capsaicin. After 5 weeks of training, measures of urge to cough and cough effectiveness increased for reflex cough; however, voluntary cough effectiveness did not increase. Swallow function was minimally impaired at baseline, and there were no significant changes in the measures of swallow function post training. **EMST improves expiratory muscle strength, reflex cough strength, and urge to cough.** Voluntary cough and swallow measures were not significantly different post training. It may be that stroke patients benefit from the training for up regulation of reflex cough and thus improved airway protection.

Gerodontology. 2016 May 16.

Effect of expiratory muscle strength training on swallowing-related muscle strength in community-dwelling elderly individuals: a randomised controlled trial.

Park JS, Oh DH, Chang My

Abstract. This study aimed to investigate the effect of expiratory muscle strength training (EMST) on swallowing-related muscle strength in community-dwelling elderly individuals. Expiratory muscle strength training is an intervention for patients with oropharyngeal dysphagia. This training is associated with respiration, coughing, speech and swallowing, and its effectiveness has been proven in previous studies. However, the effects of EMST on elderly individuals and evidence are still lacking. This study included 24 community-dwelling senior citizens aged ≥ 65 years (12 men and 12 women). The experimental group trained at the 70% threshold value of the maximum expiratory pressure using an EMST device 5 days per week for 4 weeks and comprised five sets of five breaths through the device for 25 breaths per day. The placebo group trained with a resistance-free sham device. Post-intervention, muscle strength of the bilateral buccinator and the orbicularis oris muscles (OOM) was measured using the Iowa Oral Performance Instrument. Surface electromyography was used to measure activation of the suprahyoid muscles (SM). After intervention, the strength of the buccinator and the OOM in the experimental group showed statistically significant improvement. There was also statistically significant activation of the SM. In the placebo group, the strength of the orbicularis oris muscle alone improved. No statistically significant differences between groups were found for the strength of the buccinator and the OOM and the activation.

J Oral Rehabil. 2016 May;43(5):364-72.

Effects of expiratory muscle strength training on oropharyngeal dysphagia in subacute stroke patients: a randomised controlled trial.

Park JS, Oh DH, Chang MY, Kim KM

Abstract. Expiratory muscle strength training (EMST) involves forcible blowing as a means of generating high expiratory pressure, against adjustable resistance. EMST has recently been introduced as a potential treatment for dysphagia. This study was performed to investigate the effects of EMST on the activity of suprahyoid muscles, aspiration and dietary stages in stroke patients with dysphagia. Twenty-seven stroke patients with dysphagia were randomly divided into two groups. The experimental group performed EMST with a 70% threshold value of maximal expiratory pressure, using an EMST device, 5 days a week for 4 weeks. The placebo group trained with a sham device. The EMST regime involved 5 sets of 5 breaths through the EMST device for a total of 25 breaths per day. Activity in the suprahyoid muscle group was measured using surface electromyography (semg). Further, the penetration-aspiration scale (pas) was used to assess the results of the videofluoroscopic swallowing study (vfps). In addition, dietary stages were evaluated using the functional oral intake scale (fois). The experimental group exhibited improved suprahyoid muscle group activity and pas results, when compared to the placebo group. Following intervention, statistical analysis indicated significant differences in measured suprahyoid muscle activity ($p = 0.01$), liquid pas outcomes ($p = 0.03$) and fois results ($p = 0.06$), but not semisolid type pas outcomes ($p = 0.32$), between the groups. This study confirms EMST as an effective treatment for the development of suprahyoid muscle activity in stroke patients with dysphagia. Additionally, improvements in aspiration and penetration outcomes were observed.

J Phys Ther Sci. 2016 Oct; 28(10): 2803–2805.

The Correlation of Respiratory Muscle Strength and Cough Capacity in Stroke Patients

Myeong-Rae Jo, MS, PT and Nan-Soo Kim, PhD, PT

Abstract. The purpose of this study was to investigate the correlation between respiratory muscle strength and cough capacity in stroke patients.] Forty-two stroke patients were assigned to 2 different groups (intervention group=21, control group=21). Both groups participated in a conventional stroke rehabilitation program, with the intervention group also receiving respiratory muscle training for 20 to 30 minutes a day, 3 times a week for 8 weeks. Respiratory muscle strength (maximal inspiratory pressure, maximal expiratory pressure), forced vital capacity, and cough capacity were measured. The intervention group showed significant increases in maximal inspiratory pressure, maximal expiratory pressure, forced vital capacity, and cough capacity. The change in maximal inspiratory pressure, maximal expiratory pressure, and forced vital capacity showed a significant correlation with cough capacity, with maximal expiratory pressure showing the highest correlation. The present study showed that the increase in maximal expiratory pressure plays an important role in improving the cough capacity of stroke patients.

Respir Care. 2014 Sep;59(9):1381-8. Review.

Expiratory and Expiratory Plus Inspiratory Muscle Training Improves Respiratory Muscle Strength in Subjects With COPD: Systematic Review

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Abstract. Inspiratory muscle training (IMT) produces beneficial effects in COPD subjects, but the effects of expiratory muscle training (EMT) and EMT plus IMT ventilatory training are still unclear. The aim of this study was to systematically review the effects of EMT and EMT plus IMT compared to control groups of COPD subjects. This study is a systematic review and meta-analysis. The search strategy included MEDLINE, Embase, LILACS, PEDro, and Cochrane CENTRAL and also manual search of references in published studies on the subject. Randomized trials comparing EMT and EMT plus IMT versus control groups of subjects with COPD were included. The outcomes analyzed were respiratory muscle strength and functional capacity. The search retrieved 609 articles. Five studies were included. We observed that EMT provided higher gain in maximum expiratory pressure (PE_{max} 21.49 cm H₂O, 95% CI 13.39 –29.59) and maximum inspiratory pressure (PI_{max} 7.68 cm H₂O, 95% CI 0.90 –14.45) compared to control groups. There was no significant difference in the 6-min walk test distance (29.01 m, 95% CI -39.62 to 97.65) and dyspnea (0.15, 95% CI -0.77 to 1.08). In relation to EMT plus IMT, we observed that PE_{max} (31.98 cm H₂O, 95% CI 26.93–37.03) and PI_{max} (27.98 cm H₂O, 95% CI 20.10 –35.85) presented higher values compared to control groups.

Conclusions: EMT and EMT plus IMT improve respiratory muscle strength and can be used as part of the treatment during pulmonary rehabilitation of subjects with severe to very severe COPD. Key words: COPD; obstructive pulmonary disease; pulmonary

Respir Physiol Neurobiol. 2013 Dec 1; 189(3): 10.1016/j.resp.2013.08.009.

Coordination of cough and swallow: A meta-behavioral response to aspiration

Teresa Pitts, Melanie J. Rose, Ashley N. Mortensen, Ivan Poliacek, Christine M. Sapienza, Bruce G. Lindsey, Kendall F. Morris, Paul W. Davenport, and Donald c. Bolser

Abstract. Airway protection is the prevention and/or removal of material by behaviors, such as cough and swallow. We tested the hypothesis that cough and swallow, in response to aspiration, are a “meta-behavior” and thus are coordinated and have alterations in excitability to respond to aspiration risk and maintain homeostasis. Anesthetized animals were challenged with a protocol that simulated ongoing aspiration and induced both coughing and swallowing. Electromyograms of the mylohyoid, geniohyoid, thyrohyoid, thyroarytenoid, thyropharyngeus, cricopharyngeus, parasternal, rectus abdominis muscles together with esophageal pressure were recorded to identify and evaluate cough and swallow. During simulated aspiration, both cough and swallow intensity increased and swallow duration decreased consistent with a more rapid pharyngeal clearance. A phase restriction between cough and swallow was also observed; swallow was restricted to the e2 phase of cough during chest wall and abdominal motor quiescence. These results support the conclusion that the cough and swallow pattern generators are an airway protective meta-behavior. The resulting alterations in swallow drive during the simulated aspiration protocol also supports the conclusion that the trachea provides feedback on swallow quality, informing the brainstem about aspiration incidences. The overall coordination of cough and swallow led to the additional conclusion that mechanically the larynx and upper esophageal sphincter act as two separate valves controlling the direction of positive and negative pressures from the upper airway into the thorax.

Journal of Rehabilitation Research & Development (JRRD), 5, 2, 2014 305- 310

Detraining outcomes with expiratory muscle strength training in Parkinson disease

Michelle s. Troche, PHD; John c. Rosenbek, PHD; Michael S. Okun, MD; Christine M. Sapienza, PHD

Abstract. Expiratory muscle strength training (EMST) is efficacious for improving maximum expiratory pressure (MEP), cough function, and swallowing safety in Parkinson disease (PD). However, there are no published reports describing detraining effects following EMST in persons with PD. Moreover, there are no published reports describing detraining effects following any behavioral swallowing intervention. Ten participants with PD underwent 3 mo of detraining following EMST. Measures of MEP and swallowing safety were made prior to beginning EMST (baseline), post treatment (predetraining), and 3 mo post detraining. Participants demonstrated, on average, a 19% improvement in MEP from pre- to post- EMST. Following the 3 mo detraining period, MEP declined by 2% yet remained 17% above the baseline value. No statistically significant changes were found in swallowing safety from post-EMST to post detraining period. Following the 3 month detraining period, seven participants demonstrated no change in swallowing safety, one worsened, and two had improvements. This preliminary study highlights the need for the design of maintenance programs to sustain function following intensive periods of training.

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Functional outcomes associated with expiratory muscle strength training: Narrative review

Helena Laciuga, MA; John C. Rosenbek, PHD; Paul W. Davenport, PHD; Christine M. Sapienza, PHD

Abstract. This review presents the available evidence for the effects of expiratory muscle strength training (EMST) with the use of a pressure threshold device. The investigators used computerized database searches for studies reporting the outcomes of pressure threshold EMST published after 1994. A total of 24 selected articles presented outcomes related but not limited to respiratory function, such as speech, swallow, voice, and cough function in persons with neurologic conditions such as Parkinson disease, multiple sclerosis, and Lance-Adams syndrome; in persons with respiratory diseases, such as chronic obstructive pulmonary disease; and in healthy young adults and sedentary and active elderly. Several studies demonstrated promising outcomes of EMST as a non-task-specific training for airway protection in persons with dysphagia secondary to neuromuscular impairments; however, further research is needed to confirm and generalize the reported findings.

Semin Speech Lang 2006; 27(4): 236-244

Respiratory Muscle Strength Training: Functional Outcomes versus Plasticity

Christine M. Sapienza, Karen Wheeler

Abstract. Respiratory muscle strength training is a paradigm that has been used for numerous years with a variety of populations including but not limited to spinal cord injury, chronic obstructive pulmonary disease, multiple sclerosis, Parkinson's disease, voice disordered, sedentary elderly, and healthy young. The respiratory muscle strength program discussed here is an expiratory muscle strength training and uses a pressure threshold device with a regimented treatment protocol. The primary purpose of the expiratory muscle strength training program is to promote strength in the expiratory muscles. The training protocol occurs five times per day, 5 days a week, and consists of ~15-20 minutes per day of training by the user at home. The device threshold is changed weekly by a clinician to maintain a threshold load of 75% of an individual's maximum expiratory pressure. The threshold setting of the device is always based on the individual's recorded maximum expiratory pressure generated into a digital pressure gauge. Results of 4 weeks of expiratory muscle strength training protocols indicate up to a 50% improvement for healthy subjects,[1] those with multiple sclerosis,[2] and those with spinal cord injury.[3] The potential transfer of expiratory muscle strength to functional outcomes is discussed, as well as how strength-training paradigms may influence cortical plasticity.

Dysphagia. 2011 Sep; 26(3): 218–224.

Respiratory-Swallowing Coordination and Swallowing Safety in Patients with Parkinson's Disease

Michelle S. Troche, PhD, Irene Huebner, MA, CCC-SLP, John C. Rosenbek, PhD, CCC-SLP, Michael S. Okun, MD, and Christine M. Sapienza, PhD, CCC-SLP

Abstract. The purpose of this study was to determine if individuals with Parkinson's disease (PD) demonstrate abnormal respiratory events when swallowing thin liquids. In addition, this study sought to define associations between respiratory events, swallowing apnea duration, and penetration– aspiration (P–A) scale scores. Thirty-nine individuals with PD were administered ten trials of a 5-ml thin liquid bolus. P–A scale score quantified the presence of penetration and aspiration during the swallowing of a 3-oz sequential bolus. Participants were divided into two groups based on swallowing safety judged during the 3-oz sequential swallowing: Group 1 = P–A \leq 2; Group 2 = P–A \geq 3. Swallows were examined using videofluoroscopy coupled with a nasal cannula to record respiratory signals during the event(s). Findings indicated that expiration was the predominant respiratory event before and after swallowing apnea. The data revealed no differences in our cohort versus the percentages of post- swallowing events reported in the literature for healthy adults. In addition, individuals with decreased swallowing safety, as measured by the P–A scale, were more likely to inspire after swallows and to have shorter swallowing apnea duration. Individuals who inspired before swallow also had longer swallowing apnea duration. The occurrence of inspiratory events after a swallow and the occurrence of shorter swallowing apnea durations may serve as important indicators during clinical swallowing assessments in patients at risk for penetration or aspiration with PD.

Neurology. 2010 Nov 23; 75(21): 1912–1919.

Aspiration and Swallowing in Parkinson's - A randomized trial

M.S. Troche, PhD, M.S. Okun, MD, J.C. Rosenbek, PhD, N. Musson, MA, H.H. Fernandez, MD, R. Rodriguez, MD, J. Romrell, PA-C, T. Pitts, PhD, K.M. Wheeler- Hegland, PhD, and C.M. Sapienza, PhD

Abstract. Dysphagia is the main cause of aspiration pneumonia and death in Parkinson disease (PD) with no established restorative behavioral treatment to date. Reduced swallow safety may be related to decreased elevation and excursion of the hyolaryngeal complex. Increased submental muscle force generation has been associated with expiratory muscle strength training (EMST) and subsequent increases in hyolaryngeal complex movement provide a strong rationale for its use as a dysphagia treatment. The current study's objective was to test the treatment outcome of a 4-week device-driven EMST program on swallow safety and define the physiologic mechanisms through measures of swallow timing and hyoid displacement. This was a randomized, blinded, sham-controlled EMST trial performed at an academic center. Sixty participants with PD completed EMST, 4 weeks, 5 days per week, for 20 minutes per day, using a calibrated or sham, handheld device. Measures of swallow function including judgments of swallow safety (penetration–aspiration [PA] scale scores), swallow timing, and hyoid movement were made from videofluoroscopic images. No pretreatment group differences existed. The active treatment (EMST) group demonstrated improved swallow safety compared to the sham group as evidenced by improved PA scores. The EMST group demonstrated improvement of hyolaryngeal function during swallowing, findings not evident for the sham group. EMST may be a restorative treatment for dysphagia in those with PD. The mechanism may be explained by improved hyolaryngeal complex movement. This intervention study provides Class I evidence that swallow safety as defined by PA score improved post EMST.



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