Inspiratory Muscle Training Enhances Vocal Loudness Without Exacerbating Fatigue in Persons with Advanced Multiple Sclerosis: A Pilot Study

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DISCLOSURES

Alex Burnham receives a salary from the Boston Home, the sole data collection and participant recruitment site of the research project.

All authors received grant funding from the National Multiple Sclerosis Society to support this research project. Alex Burnham has served as a volunteer consultant for the National Multiple Sclerosis Society on unrelated projects.

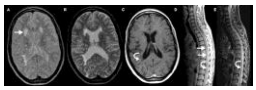
Learner Outcomes for this Session

1. Understand how inspiratory muscle strength training can positively impact vocal loudness in persons with advanced multiple sclerosis
2. Apply principles of inspiratory muscle strength training to enhance vocal loudness based on primary respiratory functional outcomes with reduced concern re: inducing increased fatigue
3. Identify additional areas of current SLP clinical practice that might elicit functional communication improvements through respiratory muscle exercise even for clients with severe accumulated disease burden from advanced multiple sclerosis

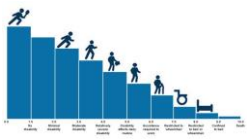
Multiple Sclerosis (MS)

- Idiopathic demyelinating autoimmune disorder
- Average age of onset 20-40
- Relapsing-remitting in earliest stages; transitions to progressive form in ~30-40% cases
- 2:1 female:male ratio
- Prevalence ~ 309.2/100,000, affecting >700,000 Americans
- Increasingly diagnosed and treated with disease-modifying therapies at earlier stages of disease

Image source: https://www.thelancet.com/cms/attachment/2000997447/2003701881/gr2.jpg



What is a person with advanced MS (PwAMS)?



- Functional turning point for people with primary (PPMS) or secondary progressive MS (PPMS)
- Can be described in terms of daily activity or disability scores, often scored on ambulation capacity
- Defined for this study as EDSS ≥ 6.5

Image source: https://img.medscapestatic.com/article/770/601/770601-fig3.jpg

Respiratory Disorders in PwAMS

- Respiratory strength declines in early stages of MS progression even without discernible impact on pulmonary function
- With accumulation of respiratory muscle weakness d/t disease progression, PwAMS experience:
  - Increased fatigue
  - Decreased exercise capacity
  - Susceptibility to pulmonary disease/infection
  - Impaired vocal loudness/hypophonia
  - Decreased social communication – increased isolation
  - Cognitive processing speed reduction

Previous Research on Respiratory Interventions for PwAMS

- Klefbeck & Hamrah (2003) = (+) improvements in maximum inspiratory & expiratory pressure (MIP & MEP) in PwAMS (EDSS 6-5-9.0) following 10-week IMT training program, no (-) fatigue impact
- Fry et al (2007) = (+) improvements in (MIP) following 10-week IMT program in people with mild-moderate MS-associated disability, no (-) fatigue impact
- Ray et al (2013) = (+) improvements in MIP, MEP, & fatigue in people less affected by MS (EDSS 1.0-6.5) following 5-week progressive resistance respiratory muscle training

Main Research Questions for This Study

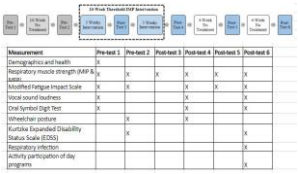
PI = Min-Hui Huang, PhD, PT, NCS (University of Michigan, Flint)

Co-investigators = Lisa Doyle, DPT, NCS (Franklin Pierce University); Donna Fry, PhD, PT, CHC (University of Michigan, Flint)

In order to expand beyond previous studies, among PwAMS:

- Does respiratory exercise improve breathing function?
- Does performing respiratory exercise increase fatigue?
- Does respiratory exercise reduce risk for respiratory infections?
- Does respiratory exercise improve vocal loudness?
- Does respiratory exercise impact socialization and activity?
- Does respiratory exercise have an effect on cognitive processing speed?

Current Study Design/Enrollment



Measurement	Pre-test 1	Pre-test 2	Post-test 1	Post-test 4	Post-test 5	Post-test 6
Demographics and health	X					
Respiratory muscle strength (MIP & MEP)	X	X	X	X	X	X
Modified Fatigue Impact Scale	X	X		X	X	X
Vocal sound loudness	X			X		X
Oral Symbol Digit Test	X			X		X
Wheelchair posture		X		X		
Kurtzke Expanded Disability Status Scale (EDSS)		X				X
Respiratory infection						X
Activity participation of day programs						X

- 37 PwAMS (EDSS > 8.0) recruited in unique residential community for adults with complex neurodegenerative disorders
- 35 completed all measures of vocal loudness and fatigue rating
- All participants completed 10-week respiratory exercise program using handheld threshold inspiratory muscle trainer (IMT) with progressive increase in resistance
- Outcomes measures were obtained pre- & post-exercise period, midway during intervention and retention phases, and at end of retention eight weeks post-exercise phase
- 10-week baseline pre-exercise period
- Repeated measures within-subject design

Intervention/Data Collection

- MIP and MEP: assess respiratory muscle strength
- Phonation assessed during three serial productions of sustained /a/
  - Peak dB SPL measured at 10-cm distance with Reed ST-805 sound level meter: assess vocal loudness
  - Recorded using a headset microphone (Sennheiser PC 8) analyzed with Praat acoustic software V 5.3.04: assess average duration in seconds between onset of phonation and termination of perceptible phonation
- Modified Fatigue Impact Scale-5 (MFIS-5) questionnaire: assess self-report of fatigue.
- IMT device usage = 3 sets of 15 breaths daily during 10-week intervention phase (participant or staff held device & documented)
- Only 1 participant reported discomfort d/t pre-existing CN V neuralgia

Outcomes: Responders & Non-Responders

- Participants who improved MIP after the 10-week IMT program = "responders" (n = 25)
- Participants without improvements in MIP ="non-responders" (n = 10)
- No demographic, functional differences, or significant findings between groups at time of baseline assessment (see below)

Baseline data by category	MIP at pre-test	MEP at pre-test	Vocal loudness	Vocal duration	MFIS-5 score
Responders	25.3±15.6 cmH2O	23.2±16.1 cmH2O	86±8 dB	8.1±4.2 s	6.5±5.4
Non-responders	29.0±18.5 cmH2O	25.9±15.4 cmH2O	88±11 dB	8.6±4.8 s	3.6±4.5

Outcomes: Maximum Inspiratory Pressure (MIP)

MIP Change Score from Baseline	Immediately post 10-wk training (p<0.001)	8-wk retention post training (p<0.001)
Responders	10.0±7.3 cmH2O	7.0±8.9 cmH2O
Non-responders	-8.8±6.8 cmH2O	-7.7±8.8 cmH2O

Outcomes: Vocal Production

- IMT responders had significantly larger vocal loudness change scores than non-responders from baseline to retention 8 weeks post intervention, with moderate effect size (see below)
  - No statistical significant between groups in vocal loudness changes from baseline-immediate post-training assessment, however
- Vocal sound duration change scores did ***not*** differ significantly between groups

Vocal parameter change scores by category	Pre-training baseline - retention vocal LOUDNESS changes (p=0.042; $\eta 2p$ = 0.12)	Pre-training baseline - retention vocal DURATION changes (p=0.192; $\eta 2p$ = 0.05)
Responders	2.9±7.4 dB SPL	-0.1±3.7 s
Non-responders	-2.8±6.1 dB SPL	-0.6±3.8 s

Outcomes: Fatigue

- Change scores of fatigue from baseline to immediate post-exercise assessment were significantly different between groups with a large effect size (see below)
- Change scores of fatigue from baseline to retention did not differ significantly between groups
- *NB: Negative score change on MFIS-5 = less reported fatigue*

MFIS-5 change scores by category	Pre-training baseline – immediate post-exercise changes (p=0.027; $\eta 2p$ = 0.14)	Pre-training baseline - retention changes (p=0.187; $\eta 2p$ = 0.05)
Responders	-1.8±5.4	-1.3±5.8 s
Non-responders	3.0±5.5	2.2±8.7

Discussion of Findings

- PwAMS responded positively to IMT training program in parameters of respiration and secondary outcomes in vocal production with very few side effects or negative consequences
- Majority of participants in this study exhibited respiratory and phonatory improvements following IMT training despite global severe disease burden accumulation
- IMT training itself does not appear to have negative impact on fatigue, a common symptom in PwAMS
- Extent of potential increase in vocal loudness after inspiratory muscle training may depend on individual response to IMT

Future Directions in Respiratory Muscle Intervention for PwAMS

- Comparison of outcomes from IMT with EMST in PwAMS
- More controlled comparison of respiratory, cognitive, and social outcomes from people at home/in community vs in LTC environment
- Exploration of other domains of verbal communication (e.g., word retrieval speed/accuracy, speech intelligibility) potentially impacted by respiratory muscle training in PwAMS
- Identification of resistance thresholds during IMT or other participant characteristics that might identify when fatigue can become confounding factor for respiratory muscle strength training

Image source:
https://hhp-blog.s3.amazonaws.com/2016/02/Deep-breathing-and-high-blood-pressure-blog.jpg

Questions & Thanks

- Thank you for your time and attention!
- Extremely special thanks to TBH residents and staff for their participation and data collection for this project
- Please contact me at aburnham@thebostonhome.org with any questions or additional feedback
- Please contact the PI, Dr. Min Hui Huang, at mhhuang@umich.edu with any questions about research protocol or future study directions
- You are invited to visit the residents and staff at Boston Home whenever you are in the neighborhood!

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