

## Cognitive and Social Participation Improvements Following Inspiratory Muscle Training 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.

### The Boston Home (TBH) Profile

- Established in 1881, "Hope over Hardship"
- 96 bed in-patient non-profit facility for adults with progressive MS and other neurological disorders
- Offers long-term and outpatient care
- Designated a *Center for Excellence in Long Term Care* by the National MS Society
- Contributed to Nursing Home Care standards for individuals with advanced MS
- Offers outpatient and independent living programs



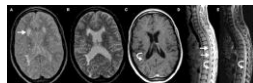
### Learner Outcomes for this Session

1. Recognize how respiratory exercise can positively impact functional measures of cognition and social participation in people with advanced multiple sclerosis
2. Identify cognitive and social participation enhancements beyond primary respiratory functional outcomes following inspiratory muscle threshold training exercises in people with advanced MS
3. Explore current SLP clinical practice to expand access to respiratory muscle strength training for clients with severe accumulated disability from advanced multiple sclerosis

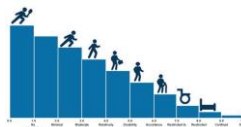
### Multiple Sclerosis (MS)

- 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/2000997447200300384/247.png>



### What is a person with advanced MS (PwAMS)?



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

Image source:  
[http://img.mindscapenews.com/article/770/661/770661\\_fig3.jpg](http://img.mindscapenews.com/article/770/661/770661_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
  - 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 6-9.0) 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

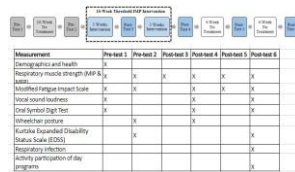
## Main Research Questions for This Study

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



- 37 PwAMS (EDSS > 8.0) recruited in unique residential community for adults with complex neurodegenerative disorders
- 32 completed all measures of cognitive processing speed outcomes
- 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
- Symbol Digit Modalities Test (SDMT) (oral version only): assess cognitive processing speed
- # days /wk on which participants within the residential community attended group activities documented by trained facility staff: assess social participation.
- 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 = 24)
- Participants without improvements in MIP = “non-responders” (n = 8)
- BMI significantly lower in responders than non-responders (p=0.046)
- No other characteristics at baseline differed between groups

MIP Change Score from Baseline	Immediately post 10-wk training (p<0.001)	8-wk retention post training (p<0.001)
Responders	10.3±7.3 cmH2O	7.4±8.8 cmH2O
Non-responders	-8.9±7.6 cmH2O	-6.5±7.8 cmH2O

## Outcomes: Cognitive Processing Speed

- SDMT scores at pre-training baseline did not differ significantly between IMT non-responders (14.5±9.8 correct items) and responders (19.8±10.9 correct items)
- Improvements in cognitive processing speed between groups reflected large effect size (see below)

SDMT change scores by category	Retention – pre-training ( $p=0.005$ ; $\eta^2p = 0.22$ )	Retention – post-training ( $p=0.009$ , $\eta^2p =0.24$ )
Responders	5.1±8.1	4.5±6.3
Non-responders	-4.8±7.72	-3.3±6.0

## Discussion of Findings

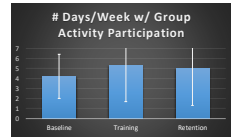
- PwAMS responded positively to IMT training program in parameters of respiration, cognition, and social interaction with very few side effects or negative consequences
- Besides enhancements in MIP, majority of participants also demonstrated enhanced cognitive processing speed following IMT training despite severe disease burden accumulation
- Participation in this exercise protocol trended towards increased social engagement (although statistical significance not found) independent from outcomes, promoting peer communication and desirable QOL for individuals coping with chronic progressive illness

## 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](mailto:aburnham@thebostonhome.org) with any questions or additional feedback
- Please contact the PI, Dr. Min Hui Huang, at [mhuang@umich.edu](mailto:mhuang@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!

## Outcomes: Activity Participation

- Structured group activity participation data across 28-week duration of study (including 10-week no-exercise baseline period prior to IMT intervention) were available for 29/32 participants
- # days with group activity attendance per week per participant = 4.2±2.2 during pre-training baseline, 5.3±3.6 during IMT training, and 5.0±3.7 during retention phase
- # days with group activity attendance/week differed significantly across time periods ( $p=0.013$ )
- Post-hoc analysis revealed that participants attended group activities across more days/week during IMT training period compared to the baseline period ( $p=0.014$ )



## 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 cognition (e.g., memory, attention) potentially affected by respiratory muscle training in PwAMS
- More feedback from PwAMS on what constitutes meaningful social participation to guide data collection/future study design

## References

- Deluca J, Barbieri-Berger S, Johnson SK. (1994) The nature of memory impairment in multiple sclerosis: acquisition versus retrieval. *Journal of Clinical and Experimental Neuropsychology*, 16(2): 183-189.
- Fry DK, Plazer LA, Chokshi AS, et al. (2007) Randomized Control Trial of Effects of a 10-Week Inspiratory Muscle Training Program on Measures of Pulmonary Function in Persons with Multiple Sclerosis. *Journal of Neurologic Physical Therapy*, 31(4): 162-172.
- Goverover Y, Hillary FG, Chiaravalloti N, et al. (2009) A functional application of the spacing effect to improve learning and memory in persons with multiple sclerosis. *Journal of Clinical and Experimental Neuropsychology*, 31(5): 513-522.
- Goverover Y, Chiaravalloti N, Deluca J. (2015) Brief international assessment of multiple sclerosis (BICAMS) and performance of everyday tasks: actual reality. *Multiple Sclerosis Journal*: 1-8.
- Kiebelack B, Hamrah J. (2003) Effect of inspiratory muscle training in patients with multiple sclerosis. *Archives of Physical Medicine and Rehabilitation*, 84(7): 994-999.
- Langdon D. (2011) Cognition in multiple sclerosis. *Current Opinion in Neurology*, 24: 244-249.
- Langdon DW, Amato MP, Boringa J, et al. (2012) Recommendations for a brief international assessment of multiple sclerosis (BICAMS). *Multiple Sclerosis Journal*: 1-8.
- Pittock SJ, Mayr WT, McClelland RL, et al. (2004) Change in MS-related disability in a population-based cohort: A 10-year follow-up study. *Neurology*, 62: 51-59.
- Ray AD, Lidhoji S, Mashtare TL, et al. (2013) A combined inspiratory and expiratory muscle training program improves respiratory muscle strength and fatigue in multiple sclerosis. *Archives of Physical Medicine & Rehabilitation*, 94(10): 1964-1970.
- Wallin MT, Culpepper WJ, Campbell JD, et al. (2019) The prevalence of MS in the United States. A population-based estimate using health claims data, 92(10): e1029-e1040.