

- Session Title: **Breath as a Biomarker: Respiratory Muscle Performance as a Vital Sign in Chronic Disease**

Session Description: Respiratory muscle performance is emerging as a powerful biomarker and therapeutic target in the management of chronic diseases, with inspiratory muscle training (IMT) demonstrating systemic benefits beyond pulmonary health. Evidence shows that IMT improves exercise capacity, autonomic balance, and quality of life across age-related conditions like heart failure, COPD, diabetes, and neurologic disorders. This symposium will explore the mechanistic underpinnings, clinical applications, and integration of respiratory muscle assessments and training into the evolving practice of respiratory muscle training. Data from a recent study performed by the speakers will provide the results of the first study examining the effects of inspiratory muscle training on respiratory muscle performance and metabolomics in heart failure from which the mechanistic underpinnings of IMT can be better understood. The effects of IMT on metabolism in patients with heart failure will be described and a laboratory session of both IMT and expiratory muscle training (EMT) will be provided.

- **Teaching Method:** Didactic lecture mixed with clinical application and photos/videos as well as a laboratory session on respiratory muscle training.
- **Objectives:**
 1. Understand the role IMT has in managing dyspnea and the pathophysiology of chronic diseases.
 2. Understand the many available methods to perform both IMT and EMT.
 3. Understand the mechanisms of action of IMT on the cardiovascular, pulmonary, and metabolic systems.
 4. Perform both IMT and EMT using a variety of different methods.
- **Clinician/educator takeaways/skills:** Understanding the mechanisms of action of IMT and EMT on skeletal muscle, the cardiovascular system, pulmonary function, and oxygen consumption as well as applying and performing IMT and EMT in subjects with chronic disease.
- **Session Outline (90 min):**
 - Introduction and clinical relevance (5 min) - Cahalin
 - Introduce speakers and brief overview of IMT and EMT
 - Dyspnea in Older Adults with CVD - *Prognostic, Clinically Impactful, and Potentially Modifiable* (20 min) – Forman

- Methods to Test and Train the Respiratory Muscles (15 min) – Cahalin
- Breath, Blood, and Biomarkers: *Mechanistic Clues and Challenges from Inspiratory Muscle Training in Heart Failure* (20 min) - Haus
- IMT and EMT Laboratory Session with Question & Answer Period (25 min) – All Speakers
- Final Question & Answer Period (5 min) – All Speakers
- **Content Level:** Intermediate to Advanced

- **References:**

1. Freeberg KA, Craighead DH, Heinbockel TC, Rossman MJ, Jackman RA, Jankowski LR, Ludwig KR, Chonchol M, Bailey EF, Seals DR. Time-efficient, high-resistance inspiratory muscle strength training increases cerebrovascular reactivity in midlife and older adults. *Am J Physiol Heart Circ Physiol.* 2023 Nov 1;325(5):H1059-H1068.
2. Craighead DH, Heinbockel TC, Freeberg KA, Rossman MJ, Jackman RA, Jankowski LR, Hamilton MN, Ziemba BP, Reisz JA, D'Alessandro A, Brewster LM, DeSouza CA, You Z, Chonchol M, Bailey EF, Seals DR. Time-Efficient Inspiratory Muscle Strength Training Lowers Blood Pressure and Improves Endothelial Function, NO Bioavailability, and Oxidative Stress in Midlife/Older Adults With Above-Normal Blood Pressure. *J Am Heart Assoc.* 2021 Jul 6;10(13):e020980.
3. Craighead DH, Freeberg KA, Heinbockel TC, Rossman MJ, Jackman RA, MCCarty NP, Jankowski LR, Nemkov T, Reisz JA, D'Allessandro A, Chonchol M, Bailey EF, Seals DR. Time-efficient, high-resistance inspiratory muscle strength training increases exercise tolerance in midlife and older adults. *Med Sci Sports Exerc* 2024;56(2):266-276.
4. Shah RV, Cahalin LP, Haus JM, Allsup K, Delligatti A, Wolf C, Checko Scioli ER, Aragam JR, Gottlieb DJ, Byard TD, Forman DE. The role of maximal inspiratory pressure on functional performance in adults with heart failure. *ESC Heart Fail.* 2024 Aug 19. doi: 10.1002/ehf2.14984.
5. Gempel S, Cohen M, Milian E, Vidret M, Smith A, Jones I, Orozco Y, Kirk-Sanchez N, Cahalin LP. Inspiratory Muscle and Functional Performance of Patients Entering Cardiac Rehabilitation After Cardiac Valve Replacement. *J. Cardiovasc. Dev. Dis.* 2023, 10, 142. <https://doi.org/10.3390/jcdd10040142>.
6. Formiga MF, Dosbaba F, Hartman M, Batalik L, Senkyr V, Radkovicova I, Richter S, Brat K, Cahalin LP. Role of the Inspiratory Muscles on Functional Performance from

Critical Care to Hospital Discharge and Beyond in Patients with COVID-19. *Phys Ther* 2023 May 29:pzad051. doi:10.1093/ptj/pzad051.

7. Palermo AE, Nash MS, Kirk-Sanchez NJ, Cahalin LP. Adherence to and impact of home-based high-intensity IMT in people with spinal cord injury: a pilot study. *Spinal Cord Ser Cases*. 2022;8(1):85. doi: 10.1038/s41394-022-00551-5.

8. Dosbaba F, Hartman M, Batalik L, Brat K, Plutinsky M, Hnatiak J, Formiga MF, Cahalin LP. The Test of Incremental Respiratory Endurance as home-based, stand-alone therapy in COPD: A case report. *World Journal of Clinical Cases* 2022;10(1):353-360. doi: 10.12998/wjcc.v10.i1.353.

9. Formiga MF, Vital I, Urdaneta G, Masters B, Herrera J, Campos MA, Cahalin LP. Higher serum levels of systemic inflammatory markers are linked to greater inspiratory muscle dysfunction in COPD. *Clin Respir J* 2019;13(4):247-255.

10. Formiga MF, Vital I, Urdaneta G, Campos MA, Cahalin LP. Beyond inspiratory muscle strength: Clinical utility of single-breath work capacity assessment in veterans with COPD. *Respir Med* 2019;147:13-18.

- **Biographical Information For Each Speaker:**

Lawrence P. Cahalin PhD, PT, CCS is a Professor in the Department of Physical Therapy at the University of Miami in Miami, Florida. He received his BS in Physical Therapy at Saint Louis University, a MA in Physical Therapy at the University of Iowa, and a PhD in Gerontology at the University of Massachusetts Boston. He enjoys integrating the interrelatedness of the cardiovascular, pulmonary, and muscular systems using novel examination and management techniques. Dr. Cahalin has been actively involved in clinical research and clinical practice in cardiovascular and pulmonary physical therapy for over 40 years.

Daniel E Forman MD, FAHA, FACC is a geriatric cardiologist at the University of Pittsburgh, Pittsburgh, PA. Dr. Forman specializes in cardiology and geriatric medicine and is board-certified in geriatric medicine and cardiovascular disease by the American Board of Internal Medicine. He practices at UPMC Senior Care Institute and is affiliated with UPMC Presbyterian, UPMC Magee-Womens Hospital, and UPMC Shadyside. Dr. Forman received his medical degree from George Washington University School of Medicine and Health Sciences and completed his residency at St. Elizabeth's Medical Center in Boston, Massachusetts, followed by fellowships at Harvard T.H. Chan School of Public Health - Division of Aging and Beth Israel Deaconess Medical Center.

Jacob M. Haus PhD is an exercise physiologist at the University of Michigan, Ann Arbor, MI. Dr. Haus is an associate professor of Movement Science and is the director of the Human Bioenergetics Laboratory (HBL) at the University of Michigan School of

Kinesiology. Before his time at U-M, Dr. Haus taught and researched in the Department of Kinesiology and Nutrition at the University of Illinois at Chicago and the Cleveland Clinic. He completed his PhD in Human Bioenergetics at Ball State University. Dr. Haus has published more than 50 articles in peer-reviewed journals, including the American Journal of Physiology, Journal of Nutrition, and Journal of Applied Physiology, and has written more than 60 scientific abstracts and conference proceedings for organizations, including the American Diabetes Association and the American College of Sports Medicine. He is an ad hoc reviewer for multiple journals in physiology and sports science, and is a member of professional organizations such as the American Physiological Society and the American Heart Association. As of this writing, Dr. Haus has been awarded 14 grants. Dr. Haus and his lab research exercise physiology and metabolism, specifically protein metabolism, skeletal muscle function with aging, and glucose and lipid metabolism. He studies mechanisms of obesity, insulin resistance, and diabetes, and how exercise and diet can reverse or prevent these conditions. His most current research involves hyperglycemia-induced protein glycation.