MAKING THE CASE FOR RESPIRATORY MUSCLE TRAINING
Sponsor: Cardiovascular and Pulmonary Section
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DISCLOSURES
Hellyer: no relevant financial relationship exists
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**COURSE DESCRIPTION AND OBJECTIVES:**
The reported clinical benefits of respiratory muscle training include improved pressure generation by the respiratory muscles, reduced dyspnea, increased functional activity and endurance, and heightened athletic performance. However, respiratory muscle training has not been widely adopted into routine physical therapy practice. The purposes of this educational session are to help participants determine which patients may benefit from respiratory muscle training, and to characterize the essential components of an exercise prescription designed to improve the performance of the inspiratory and expiratory muscles.

This session will provide the physiological rationale for incorporating respiratory muscle training into physical therapy practice to reverse respiratory muscle weakness and fatigue, in order to improve patient outcomes, function and quality of life. The speakers will synthesize basic and clinical evidence discussing how an elevated work of breathing influences fatigue, muscle injury, and exercise performance. We will then explore clinical manifestations associated with respiratory muscle weakness and the functional problems related to disuse atrophy. Speakers will evaluate exercise prescriptions specifically designed to improve respiratory muscle strength, alleviate respiratory muscle fatigue, and enhance functional performance. Special consideration and discussion will be given to clinical scenarios of chronic obstructive pulmonary disease, spinal injury, neurological disease (MS) and prolonged mechanical ventilation.

**Upon completion of this course, participants will be able to:**
- Contextualize the use of standardized measures of respiratory muscle function in clinical practice, to determine whether training is indicated and to gauge progress
- Recognize clinical signs and symptoms of respiratory muscle fatigue, and the role of chronic loading and fatigue in muscle injury.
- Contrast the effects of respiratory muscle disuse versus reloading on muscular size and strength.
- Discuss the influence of respiratory muscle weakness on the drive to breathe and the perception of dyspnea
- Identify patient applications for respiratory muscle training in cases of neuromuscular disease, COPD, spinal injury, and prolonged ventilator dependence.
- Individualize a patient-centered, respiratory muscle training exercise prescription

**SCHEDULE:**
- 11:00-11:20 Physiological Problem: Respiratory Muscle Fatigue
- 11:20-11:40 Clinical Application: Respiratory Muscle Training for Multiple Sclerosis
- 11:40-12:00 Clinical Application: Inspiratory Muscle Training for Individuals with COPD
- 12:00-12:20 Physiological Problem: Respiratory Muscle Weakness
- 12:20-12:40 Clinical Application: Respiratory Muscle Training for Inactivity and Spinal Injury
- 12:40-12:55 Clinical Application: Respiratory Muscle Training to Facilitate Weaning from Mechanical Ventilation
- 12:55-1:00 Conclusions
PHYSIOLOGICAL PROBLEM: RESPIRATORY MUSCLE FATIGUE
W. DARLENE REID, BMR, PHD

1. The Respiratory Muscle Pump
   a. Key muscles of inspiration
   b. Diaphragm structure and function
   c. Estimates of muscle force – mouth, transdiaphragmatic pressures
   d. Estimates of muscle length – lung volumes

2. Measures of Inspiratory Muscle Endurance
   a. Maximal incremental threshold load
   b. Maximal sustainable mouth pressure
   c. Maximum sustained ventilatory capacity

3. Devices used for respiratory muscle training
   a. Resistive trainer without a target
   b. Threshold trainer
   c. Normocapneic hyperpnea

4. Mechanisms of muscle fatigue
   a. EC coupling
   b. Protection from metabolic catastrophe
   c. Respiratory muscle metaboreflex

5. Muscle Injury –
   a. Manifests as structural disruption, weakness, biochemical changes, presence of plasma markers
   b. Ultrastructural and structural changes: injury and inflammation

6. Distinguishing Fatigue, Weakness and Injury

7. Disorders that Overload Respiratory Muscles
   a. Decreased strength
   b. Increased work
   c. Decreased efficiency
   d. Promoters of fatigue and injury vs promoters of muscle performance

Key References


**CLINICAL APPLICATION: RESPIRATORY MUSCLE TRAINING IN MULTIPLE SCLEROSIS**

ANDREW RAY, PHD, PT

1. Background of multiple sclerosis
   a. Epidemiological
   b. Pathophysiological

2. Pulmonary complications in MS
   a. Correlation between pulmonary function and functional status in MS
   b. Correlation between pulmonary function and disability in MS

3. Respiratory muscle training for people with MS
   a. Expiratory muscle training
   b. Inspiratory muscle training
   c. Combined inspiratory and expiratory training

4. Newly released data
   a. Respiratory dysfunction and MS-related fatigue

**Key references:**


Inspiratory muscle training has been well studied in people with COPD and is used in isolation, as well as in conjunction with whole body exercise training. There are several systematic reviews on this topic, which provide an excellent basis for evidence-based guidelines in this area.

The objectives of this presentation are to:
1. discuss the rationale for using IMT in people with COPD
2. review the evidence for IMT in people with COPD, using recent meta-analysis and systematic review
3. provide exercise training prescription principles for IMT in COPD
4. provide guidelines for safety monitoring during and after a session of IMT

Summary of Key Points:
1. Rationale for using IMT
   a. diaphragm fatigue and weakness in COPD
   b. structural and cellular changes in the diaphragm muscle in COPD

2. Review of the evidence
   a. effects of IMT alone and in conjunction with exercise training on key outcomes such as inspiratory muscle strength and endurance, dyspnea, exercise capacity, quality of life
   b. identify which people with COPD are the “best candidates” for IMT based on the evidence

3. Exercise training principles
   a. comparison of inspiratory muscle strength vs endurance training parameters used in COPD
   b. discussion of the training devices typically used in pulmonary rehabilitation

4. Safety and Monitoring
   a. guidelines for safe exercise progression
   b. guidelines for monitoring vital signs (SpO2, HR, dyspnea) and risk of muscle damage

Key References:


PHYSIOLOGICAL PROBLEM: RESPIRATORY MUSCLE WEAKNESS
DANNY MARTIN, PHD, PT

1. Background and Scope: Prolonged Ventilator Dependence in the US
   a. Cost
   b. Incidence

2. Key Physiological Determinant:
   a. Imbalance between the load needed to tidally breathe, in relation to the maximal capacity of the muscle pump

3. Effects of MV on inspiratory neuromuscular function
   a. Significant diaphragm fiber atrophy in humans
   b. Rapid gene expression changes
   c. Animal MV
   d. Human surgery
   e. Atrophy and inflammatory marker upregulation, with anabolic downregulation
   f. Decreased maximal diaphragm force

4. Effect of increasing diaphragm activity during MV
   a. Assist modes of MV vs controlled MV
   b. Intermittent spontaneous breathing
   c. Respiratory muscle training exercises
   d. Phrenic stimulation during surgery- potential preventative intervention?

Key References:


CLINICAL APPLICATION: RESPIRATORY MUSCLE TRAINING FOR PERSONS WITH CERVICAL SPINAL CORD INJURY
NATHAN HELLYER, P.T., PH.D.

1. Introduction/Background
   a. Overview of ventilatory impairments occurring with cervical spinal cord injury (SCI).
   b. Effect of SCI on diaphragm muscle force generation and selective fiber-type atrophy.

2. Clinical application of respiratory muscle training (RMT) for cervical SCI
   a. Rationale for respiratory muscle training (RMT) in persons with cervical spinal cord injury.
   b. Diaphragm motor unit recruitment order and fatigability with ventilatory and non-ventilatory behaviors.
   c. Review of currently available clinical evidence for using RMT as an intervention for persons with cervical SCI.

3. Clinical questions that may need to be considered with regard to RMT in persons with SCI
   a. Limitations of RMT in persons with SCI.
   b. Identifying appropriate outcome measures for RMT in persons with SCI.

Key References:


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CLINICAL APPLICATION: RESPIRATORY MUSCLE TRAINING TO FACILITATE WEANING FROM MECHANICAL VENTILATION
BARBARA K. SMITH, PT, PHD

1. Evidence review: what are the benefits of respiratory muscle training?
   a. Strength and muscle performance
   b. Function – weaning outcome, airway clearance
   c. Hospital-related indicators of success – length of stay, cost, survival?

2. Key distinctions and considerations for applying respiratory muscle training to ventilator-dependent patients
   a. Medical acuity: contra-indications and precautions
b. Neurological factors
c. Physiological reserve and monitoring

3. Shared considerations for the respiratory muscle training exercise prescription
   a. Frequency, intensity, type, time
   b. Interfaces for adults and children
   c. Future Directions

Key References:


