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# Airway Clearance Techniques and Respiratory Muscle Training: Applications for Speech-Language Pathology

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# Airway Clearance Techniques and Respiratory Muscle Training Applications for Speech Pathology

Mary Spremulli, MA,CCC-SLP

# Disclosure Statement

Financial:

- I will receive a speaker's fee for developing and presenting today's webinar.
- I am owner of Voice Aerobics, LLC, a speech-language pathology private practice, and distributor of The Breather,® one of the products referenced today.
- I am a Clinical Consultant with Passy-Muir and occasionally receive a speaking fee.

Non Financial:

- No disclosures

# Why I developed this course:

- SLPs increasingly recognize that oral and pulmonary hygiene are important components of dysphagia intervention.
- PEP devices (positive-expiratory pressure therapy) devices have been available for nearly 30 years and can serve as an adjunct to manual methods of facilitating airway clearance in patients with pulmonary and neuromuscular diseases
- Knowledge about various methods of improving pulmonary hygiene and improving respiratory muscle use and strength may be of benefit to SLPs who wish to incorporate these modalities into treatment.

Various **techniques** can be integrated into treatment to:

- improve breathing for speech and swallowing
- mobilize secretions
- improve pulmonary hygiene for patients with acute and chronic pulmonary infections or weak cough effort due to neuromuscular diseases

## Why I developed this course:

- Most reports in the literature since the early 1980's examining effects of resistive breathing exercises indicate that the respiratory muscles respond favorably to this type of exercise.
- Until fairly recently, respiratory muscle training (RMT) has focused primarily on the inspiratory muscles, with improvements reported on pulmonary function and quality of life measures.
- Recent research using an EMST device has shown positive effect on improving swallowing and cough effort in persons with neurodegenerative and neuromuscular diseases, suggesting a role for inspiratory and expiratory muscle training.

## Overview/Objectives of Course (Adult Focus)

- A basic review of the pulmonary system .
- The role of the respiratory muscles in breathing.
- Disease states which affect pulmonary function and respiratory muscle use.
- Airway clearance techniques including manual and device interventions.
- Respiratory muscle training (RMT) and trainers.
- RMT in speech and swallowing treatment case review.

# Course Objectives:

**After this course, participants will be able to:**

- Describe the impact of pulmonary disease/s, acute and chronic, on functional activities including communication and swallowing, stamina, airway clearance and quality of life.
- Apply principles of non-invasive airway clearance, PEP therapy and device interventions.
- Describe respiratory muscle trainers, including: types, indications, and their role in improving pulmonary function, including secretion clearance.
- Explore the role of respiratory muscle training in speech therapy treatment, and for the prevention and management of aspiration pneumonia.

# Full Disclosure: My Clinical History (Bias) with Today's Topic

# Brief Review of the Pulmonary System

## Breathing and Respiration: same or different?

**Breathing/Ventilation**

- Allows us to take in oxygen from the external environment, and remove the waste product Carbon Dioxide from our body.
- It is a two-step process of **ventilation** and gas exchange.
- Respiratory muscles serve as the "pump, and some aspects of breathing can be modified, such as rate and depth of breathing.
- Adults average between 18,000 - 30,000 breaths per day, and by age 70 will have taken 600 million breaths.

**Respiration**

- Refers to the exchange of $CO_2$ and oxygen that occurs between the alveoli and the blood vessels.
- An involuntary chemical process, by which the body makes energy by reacting to oxygen from your lungs and glucose from your food.

# Brief Review of the Pulmonary System Breathing and Respiration

- **Diffusion** occurs when molecules move from an area of high concentration to an area of low concentration.
- **Diffusion** occurs during gaseous exchange as $O_2$ moves into the capillaries and $CO_2$ diffuses from the capillaries, into the alveoli where it can then be exhaled.
- Pulmonary elastic behaviors depend on alveolar surface tension. Surfactant lowers surface tension and reduces tendency to collapse.

## Brief Review of the Pulmonary System Breathing and Respiration

- Breathing is a part of the **cardio-pulmonary system.**
- **Perfusion** is the movement and distribution of blood through pulmonary circulation.
- Blood is nearly 100% saturated with O2 when it leaves the lungs, and increasing breathing cannot improve oxygen transport.
- Patients may have medical diagnosis that involve both systems.

## The Role of the Respiratory Muscles and the Mechanics of Breathing

- The action of breathing in and out is due to changes of pressure within the thorax.
- The intercostal muscles and diaphragm contract to expand the chest cavity, and air from the outside rushes into the lungs to equalize the pressures.
- Pleural space has slightly negative pressure because chest is pulling out, lungs are pulling in, and there's no extra fluid to fill expanded space.
- **Accessory inspiratory muscles** (SCM, scalenes, alae nasi, small muscles of neck/head) to raise sternum & first 2 ribs
- On exhalation the diaphragm and intercostal muscles relax , return to their resting position, **lung recoil forces** increase the pressure and forces air out of the lungs.

## The Role of the Respiratory Muscles and the Mechanics of Breathing

- **Inspiration is always active.** Expiration is passive during quiet breathing due to elastic recoil of lungs.
- During tasks e.g.: cough, heavy lifting, or resistance training, increased intra-abdominal pressure → pushes diaphragm up → and lungs are emptied more forcefully.
- During **active expiration** (e.g. heavy breathing, exercise, speech tasks, RMT) **abdominal muscles contract.** (External & Internal Obliques, Transversus abdominis, Rectus abdominis)
- The diaphragm forms the top of the ''core 'box' and helps with spinal stability, pushing, heavy lifting, balance and trunk rotational movements.
- Studies have shown that nonrespiratory maneuvers such as sit-ups and bicep curls can improve inspiratory and expiratory muscle strength, and diaphragm strength. (DePalo et al)

## Mechanics of Breathing "Work of Breathing"

**Amount of inspired air that makes it to alveoli depends on:**

- Strength of pump (muscles)
- Airway resistance
- Elasticity/compliance of lungs and rib cage
- Tissue resistance – frictional resistance of lungs and chest wall.
- Inertia – energy must be expended to set system in motion
- Need to overcome stiff/elastic recoil, frictional resistance.

# Work of Breathing

- **VO2** is the measure of oxygen you can consume and use in a minute and is measured relative to body weight.
- VO2Max is a maximum rate at which an individual can consume O2 during exercise or maximal exertion.
- VO2 Max can be increased through training as ventilation increases to meet the demands of exercise, causing adaptations within the cardiovascular, respiratory and muscular systems.
- When oxygen utilization is at its peak, as with intense exercise, the anaerobic energy system comes into play.
- Anaerobic metabolism produces lactic and carbonic acid causing fatigue and cannot be sustained.
- Anaerobic energy production also results in oxygen debt, so in some disease states, patients may have a deficit due to lung disease and/or respiratory muscle weakness.

# Breathing Rate

- **Breathing Rate** in an adult at rest is 12-20 BPM and is controlled in part by the respiratory centre within the Medulla Oblongata in the brain.
- Inspiration and exhalation occurs in response to impulses along the nerves and motor units within the intercostals and diaphragm.
- Lungs are prevented from excess inspiration due to stretch receptors within the bronchi and bronchioles which, when stimulated, send impulses to the brainstem.

## Breathing Rate

- **Breathing rate** is also controlled by baroreceptors within the main arteries which sense the partial pressures in respiratory gases ($O_2$ and $CO_2$)and pH in the arterial blood.
- Breathing (ventilation) accelerates in response to falls in oxygen and increased $CO_2$.
- Breathing rate also increases when carbonic acid and lactic acid is released into the blood following high intensity exercise.

## Pulmonary Function Testing (PFT)

**What can spirometry tell us?**

- Spirometry measures the rate of lung volume changes during forced breathing maneuvers.
- The values measured are important when diagnosing and distinguishing between **obstructive and restrictive** lung diseases.
- Spirometry tests almost always include a bronchodilator challenge.

## Pulmonary Function Testing (PFT) Accuracy of Testing May Be Influenced By:

- Insufficient effort due to illness or pain.
- Not understanding test instructions.
- Coughing at any time during the maneuver.
- A hesitation causes air to cease flowing, such as a valsalva.
- Inadequate seal or obstruction around the mouthpiece.
- Poor upper airway valving due to hypotonicity associated with neuromuscular disease.

## Respiratory Volume

- **Tidal Volume(TV or VT)** The amount of air which enters the lungs during normal inhalation at rest and leaves on exhalation. The average tidal volume is 500 ml.
- **Inspiratory Reserve Volume(IRV)** The amount of extra air inhaled (above tidal volume) during a deep breath. This can be as high as 3000ml.
- **Expiratory Reserve Volume(ERV)** The amount of extra air exhaled (above tidal volume) during a forceful breath out.
- **Functional Residual Capacity (FRC)** Volume of air in lungs after normal passive expiration.
- **Vital Capacity(VC)** The most air you can exhale after taking the deepest breath you can. It can be up to ten times more than you would normally exhale.
- **Forced Vital Capacity Maneuver (FRC)** Total volume expired from maximum inspiration to maximum expiration (approx 80-120% of normal VT).
- **Residual Volume(RV)** The amount of air left in the lungs following a maximal exhalation. (Some air always remains)
- **Total Lung Capacity(TLC)** This is the vital lung capacity plus the residual volume and is the total amount of air the lungs can hold. The average total lung capacity is 6000 ml, although this varies with age, height, sex and health.

## Respiratory Inductance Plethysmography

- Non-invasive measurement of respiratory volumes.
- An elastic belt fastened around the chest or abdomen will exhibit a change in tension as the chest or abdomen expands or contracts.
- Calculates chest and abdominal expansion, respiratory rate, respiratory pattern, and tidal volume.

## Non-Instrumental Measures of Breathing

**Patient Self-rating scales:**

- **Borg Scale** for Rating of Perceived Exertion and Modified Borg
- **MMRC Dyspnea Scale**
- **6 minute walk test** widely used for preoperative and postoperative evaluation, for measuring the response to therapeutic interventions, and pulmonary and cardiac disease
- **Chronic Respiratory Questionnaire** (CRQ-SR)(self-reported by patient) Disease specific quality of life questionnaire.
- Ambulation distance in a 6-minute test is known to be a predictor for mortality and morbidity, especially for COPD patients having tolerable distances less than 274 meters (8.5ft)

Martinez FJ, Resp Critical Care 2006

## Pulmonary Disease States that Affect Breathing and Airway Clearance

**Obstructive**

- Difficulty expelling all the air from the lungs (increased residual volume or air trapping).
- COPD
- Emphysema, Cystic fibrosis
- Asthma
- Chronic bronchitis, bronchiectasis

**Restrictive**

- Lungs are restricted from fully expanding, making it difficult for a person to take a full breath (reduced total lung capacity).
- **Intrinsic**: sarcoidosis, pneumonia, fibrosis
- **Extrinsic:** kyphosis, scoliosis, tumors, rib fx.

## Neurological, Neurodegenerative, and Neuromuscular Diseases with Respiratory Muscle Weakness

- **Respiratory failure and pneumonia are the primary causes of death** in most cases of neuromuscular disease**. (Respir Care 2006)**
- Options for severe respiratory insufficiency include:
  - Non-invasive ventilation.
  - Non-invasive cough support therapies and devices.
  - Mechanical ventilation/tracheostomy
- Spinal cord injuries
- Polio and late effect polio
- ALS
- Parkinson's disease(PD), PSP,MSA
- Multiple Sclerosis (MS)
- Muscular dystrophy (MD)

## Cough and Airway Clearance

- The primary limitation in the secretion management of patients with neuromuscular and respiratory diseases is **cough clearance due to cough insufficiency**.
- Cough can be elicited from the larynx, trachea, or bronchi, and classified as: irritant, voluntary, or reflex.
- LCR and VCR or irritant different neurological pathways (brainstem v/s cerebral cortex.) (Widdicombe,2006)

**Sequence of Phases in Cough**:

- Rapid inhalation to near VC.
- Compression: adduction of the glottis with onset of expiratory muscle contraction and compression of alveolar gas volume.
- High expiratory flow and dynamic compression= effective cough

## Airway Clearance in Non-disease States

- **The normal mechanism of airway clearance** of secretions from the lungs is the **mucociliary escalator** and **cough**.
- **Cough is a back-up mechanism**, and the first line of defense is physical removal by mucus; the entire respiratory system is lined with goblet cells that secrete mucus.
- The **upper airway** also plays an important role in airway clearance.
  - Our nose warms, filters and humidifies airstream.
  - Larynx defends against inhaled foreign matter, and filters particulates.
  - The viscosity of mucus also affects cough efficiency.
- **Cough effectiveness** depends on the coordinated reflex action of the glottis in conjunction with both inspiratory and expiratory phases necessary to produce maximum cough flow.

# Cough strength

- Peak inspiratory (PIP) and peak expiratory pressures (PEP)measured by PFT provide information about respiratory muscle strength.
- The peak cough expiratory flow (PCEF) needed for an effective cough in adults is 162 L/min, with adults having normal peak cough flows of 360 to 720 L/min. (Boitonao, 2006)
- In bulbar disease, poor glottic function can limit the rate of inspiratory airflow, and reduce effectiveness of the compression and expulsion phase of cough .

# Airway Clearance in Non-disease and Disease States

- Approximately half of all healthy adults aspirate small amounts of oropharyngeal secretions during sleep without pulmonary sequelae.
- Low virulent bacterial burden of normal pharyngeal secretions, forceful coughing, active ciliary transport, and normal immune mechanisms result in clearance of the material without sequelae. (Marik, Chest, 2003)
- **The protective mechanisms provided by effective pulmonary-hygiene may be lacking or deficient in acute and chronic disease states**.
- Influencing factors for development of aspiration pneumonia:
  - ⇩ **mobility**
    **COPD/tobacco use**
  - ⇩ **CVA or 3+ medical dx.**
    **cough**
  - ⇩ **cognition**
    **desensate larynx**
  - ⇩ **sedation**
    **oral hygiene**
    **dependence in oral feeding**
    **advanced age**

(Langmore et al,Dysphagia 1998, Hibberd, Multidisciplinary Respiratory Medicine 2013)

## Age Related Changes May Affect Breathing and Cough Efficiency

- Reduced chest wall compliance due to rib cage and postural changes due to osteoporosis and kyphoscoliosis.
- Diaphragm weakness.
- Immune system changes affecting ability to fight infections.
- Expiratory intercostal muscle atrophy by approximately 20% after 50 years of age, possibly due to a more sedentary lifestyle.
- Reduced lung elasticity

(Haas, Carl, MLS RRT FAARC 2007)

## Airway Clearance Techniques: What do we know?

- For close to 30 years, airway clearance techniques have served as a cornerstone of management for adult and pediatric patients.
- Clearance of secretions via manual techniques and device interventions have been shown to relieve atelectasis, reduce ineffective coughing and prevent or slow the destruction of the airways by discouraging bacterial colonization.
- **"The correct choice may be an airway clearance strategy that is clinically and cost effective, and preferred by the patient so that adherence and compliance can be at the very least supported. "**

(Respiratory Care 2007)

# Airway Clearance Techniques

**Manual Methods**

**Chest Physiotherapy (CPT)**

- Postural drainage
- Percussion and vibration.
- **Active cycle breathing*** (deep breathing or breath stacking)
- Forced expiratory technique **(Huff cough*)**
- **Pursed lip breathing***

* **Can be utilized by SLP and taught to patient. Require no equipment.**

**PEP Devices (positive-expiratory pressure therapy)**

- Acapella® (Smiths Medical)

- Resistex® (Mercury Medical) can be used with mask or mouth nebulizer tx.

- Flutter® (Cardinal Health)

# Airway Clearance Techniques

**Vest® Airway Clearance System** **www.Vest.com**

Pressure pulses fill the vest and vibrate the chest wall.

- **Medications (Mucolytics)** aid sputum clearance by reducing sputum viscosity and facilitating expectoration.
- **Hydration** reduces viscosity of sputum. (Restricted fluids or modified liquids?)

**Cough Assist Device (In/Exsufflator)**

**(Respironics)**

- Portable electrical device that alternatively applies positive and rapid negative pressure to patient's airway to assist in stimulating cough and secretion clearance.
- Used where weak cough function is the sole impediment to normal secretion clearance; i.e.,ALS, Late effect polio, MD

(Re-imbursed by CMS for home use with appropriate qualifying ICD-9 codes.)

## Respiratory Muscle Training (RMT)

- Response of respiratory muscles to endurance and strength training stimuli was shown first by Leith and Bradley in 1976 using healthy subjects.
- Studies on the use of **resistiv**e breathing exercise have shown, between studies but not for every participating subject, that respiratory muscles respond favorably to resistive breathing exercise.
- **Most research has focused on IMT effect** on: symptoms, lung function, exercise capacity, and quality of life
- Recent research has focused on RMT as a preventative tool for:
  - Pre and postoperative patients undergoing cardio-thoracic surgery or abdominal surgery. (Westerdahl, Chest 2005)
  - Stroke patients with dysphagia to prevent aspiration pneumonia. (Pollock, RD International Journal of Stroke © 2012 )
  - **EMST** for improving cough effort in persons with hypotussis. (Wegland and Sapienza 2013)

## RMT and Principles of Exercise Training

- A muscle will only strengthen when forced to operate beyond its customary intensity (overload).
- Muscle growth depends on the muscle fiber type activated and the pattern of recruitment.
- Fast twitch(Type IIa- IIb) produce more force (strength), are fatigable and more reliable on anaerobic respiration.
- Slow twitch (Type I) resistant to fatigue (endurance) are more energy efficient than fast-twitch fibers, and primarily rely on aerobic respiration or oxygen to produce energy.
  - **Resource: The Dysphagia Workout: Applying Exercise Principles into Treatment Lori Burkhead Morgan, Ph.D., CCC-SLP . Speechpathology.com**

## RMT and Principles of Exercise

- Slow (type I) fibers and fast (type II) fibers are present in equal proportions in the adult human diaphragm.
- Diaphragm fibers are resistant to fatigue required by their continuous activity.
- Intercostals muscle contain a higher proportion of fast fibers, and are less resistant to fatigue.
- The structural and functional characteristics of respiratory muscle fibers are not fixed.

Changes in muscles can occur in response to:

- Training (adaptation to changes in respiratory load)
- Adaptation to hypoxia
- Age related changes
- Changes associated with respiratory diseases and medications. (Polla, 2004)

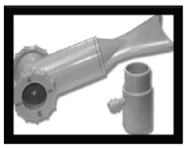
## RMT and Principles of Exercise

- Like skeletal muscles, respiratory muscles respond differently to different training stimuli. i.e.
- High tension/load, low repetition mainly improves **strength**.
- High repetition, low tension/load, will increase **endurance.**
- Low resistance RMT may be used for:
  - Breathing pattern re-education
  - Active ROM exercise to improve thoracic expansion
  - Improve motor coordination and proprioceptive input

## Respiratory Muscle Training: Does it Work?

- Most studies show some positive findings with RMT, but there are also identified flaws:
  - different medical dx
  - types of devices
  - different projected outcomes
  - targeted v/s non-targeted training
  - endurance v/s strength training
- When different training methodologies are compared, **the most important criterion for strength training** is that the load must be 30% of the maximal strength of the respiratory muscles. ( 30-60% most common).

**Targeted** training device such as The Threshold® IMT (Respironics)



Flow resistance or **non-targeted** device. The Breather® Inspiratory/Expiratory Resistive Respiratory Muscle Trainer (PN Medical)

## Respiratory Muscle Training How Can It Help?

### IMT/IMST

- Increased strength and endurance of respiratory muscles.
- Delayed onset of respiratory fatigue.
- Prevents/deters onset of respiratory failure.
- Improved ventilation.
- Facilitates weaning from ventilation.
- Improved sense of well being/quality of life.

(Bach,JR,MD,1996)

### EMT/EMST

- Improves voluntary cough and cough capacity.
- Improves maximal expiratory pressures.
- Increases expiratory driving force to augment speech or swallow. (Kim/Sapienza 2005)
- Enhances the effectiveness of ventilation during exercise.

# Respiratory Muscle Trainers

- Proprietary Devices
- Design Differences
- Indications for Use

❖ Refer to manufacturer websites for specific protocols, research and studies and proposed benefits.

## (RMT) Inspiratory-Expiratory Flow Resistance Training

- Inspiratory-expiratory flow resistive loading (IEFRL) requires individuals to inspire (and/or expire) via a variable-diameter orifice. The smaller the orifice the greater the resistive load.
- Inspiratory-Expiratory pressure, and training load, varies not just with orifice size but also with flow.
- Lung function improvements have been reported with this type device when training was conducted over a 10 wk period. (Litchke, Med 2008)

# (RMT)

## Inspiratory-Expiratory Flow Resistance Training

- **It is important that the breathing pattern is monitored during IEFRL** if a quantifiable training stimulus is to be provided.
- IEFRL can be supplemented with feedback control of rate, used with a manometer or with SEMG biofeedback to set targets for the patient.
- IEFRL may lack sufficient load for strengthening for healthy individuals, but may be suitable for endurance.
- IEFL for ROM and as a PEP device for positive expiratory pressure.

George: Parkinson's and RMT
Video 1

## (RMST)Respiratory Muscle Strength Training Inspiratory-Expiratory

- Power Lung® I/E threshold trainer uses stacking cells, similar to stacking weights to create a **progressive threshold resistance**.
- Independent research has reported post RMT improvements or change in:
  - Respiratory muscle strength or endurance.
  - Specialized therapeutic uses would be off-label.
  - www.powerlung.com Studies & papers
- Protocols vary depending on goals; e.g. 3 sets of 10 breaths for strength training or 3 sets of 30 breaths for endurance.
- Various models and levels of resistance from light activity to Elite athletes

## Inspiratory Muscle Training (IMT) Inspiratory Pressure Threshold Loading (IPTL)

- IPTL requires individuals to produce an inspiratory pressure sufficient to overcome a negative pressure load and thereby initiate inspiration.
- Threshold loading permits variable loading at a quantifiable intensity by providing near flow independent resistance to inspiration.
- Spring loaded valve only opens when the inspiratory pressure generated by the patient exceeds the spring tension.

The Threshold® IMT Respironics

- Threshold loading has been shown to induce improvement in inspiratory muscle strength and endurance, thereby reducing "work of breathing".

# (IMST) Inspiratory Pressure Threshold loading (IPTL)

**Most training protocols recommend:**

- Inspiratory load 30–60% of MIP
- Training up to 30 min or split sessions x's 6wks. Or more.
- Increase load weekly, to required percentage of new MIP.
- No contraindications for IMT except patients with unstable asthma, low perception of dyspnea or history of spontaneous pneumothorax. *(Magadle R, Chest 2002*
- De-training by 6 months of no device use

- Research outcomes suggest that patients undergoing IMT should experience improvements in:
  - ➢ MIP
  - ➢ Inspiratory muscle endurance
  - ➢ Dyspnea and exertional exercise tolerance
  - ➢ Perhaps quality of life.
- IMT may lead to a decrease of the inspiratory time, which leads to longer exhalation time. (Petrovic, 2012)
  - ➢ Can this be beneficial for swallowing timing and efficiency?

# Expiratory Muscle Training (EMT) and Expiratory Pressure Threshold Loading (EPTL)

**EMT Research using modified IMT or resistance device**

- Suzuki, et al reported that EMT reduces the sensation of respiratory effort during exercise in normal subjects. (Suzuki, Thorax, 1995)
- The expiratory muscles can be specifically trained with improvement of both strength and endurance in patients with COPD. (Weiner, CHEST 2003)
- EMT training tended to improve cough efficiency and the perception of dyspnea in children with neuromuscular disease. (Gozal, 1999)
- Strengthening the chest wall muscles to any degree may enhance their capability and result in improved respiratory function (Roth 2010)

**EMST (Expiratory Muscle Strength Training) using a proprietary device.**

- EMST™-150 is a calibrated expiratory muscle strength trainer designed to enhance breathing, swallowing, and cough function.
- EMST is focused on improving strength of the respiratory muscles not normally exposed to loaded exercise.

# EMST
## Expiratory Pressure Threshold Loading

- Strengthening expiratory muscles by EMST can enhance the ability to generate more expiratory force, and thereby increase expiratory flow force and rate for cough, and overlaid functions such as speech, and swallowing. (Kim/Sapienza JRRD,2005)
- Increased activation & higher amplitude of submentals . (Wheeler et al 2007)
- EMST™-150 spring loaded design. Isometric contraction of expiratory muscles i.e. pressure v/s flow to open valve. Effort is set at 75% of maximum.
- Specific protocol based on research: "Think 5"
- 5 Breaths/reps – 5 sets each day for 5 weeks

- **Patient requires:**
  - sufficient lung power
  - lip seal
  - cognitive ability
- EMST training has been associated with improved:
  - Cough and clearance of secretions.
  - Cough and swallow in persons with PD
  - Improved breath support use for players of wind instruments and voice.

http://emst150.com/research.html

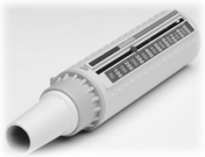
Howard: PSP, Transition From IEFRT to EMST Video 2

## Low Tech Tool Box: Is My Patient Ready for RMT?

Manometer for feedback and calibration with non-targeted trainers and when transitioning from one device to another.

Incentive Spirometer


Digital/finger Pulse Oximeter



Peak Flow Meter

## Low Tech: Controlled Breathing Exercises (CBE)

### Pursed Lips Breathing

- Slow breathing down and improve the exchange of oxygen and carbon dioxide.
- Prolong exhalation and keep airways open longer. (physiologic PEEP)
- Reduce the work of breathing, i.e. exertional dyspnea in COPD pt. (Nield PhD, RN,2007)
- Increase the amount of time patient can exercise or perform an activity.
- http://www.copdfoundation.org/

### Diaphragmatic Breathing (Abdominal/Belly Breathing)

- Designed to re-train the breathing pattern. Often a component of voice tx.
- May improve lung volumes and timing of breathing and swallowing, with or without device intervention.
- Patients who performed deep-breathing exercises after CABG surgery showed a significantly smaller amount of atelectasis compared to patients who performed no breathing exercises. (Westerdahl, Chest 2005)

## Respiratory Muscle Use for Speech, Swallowing, and Pulmonary Hygiene

## What are the Goals for Your Patients? Lessons from Sports Training:

- Can't do specialized exercise unless you have a base - then you can handle the intensity.
- Low level and high level athletes (patients) need muscular endurance, not just strength.
- One needs to prepare the body, providing a base for specialized training (skills practice).

Yessis, PhD, Sports Training

Train the pre-requisites required to execute the skill.

## What Are the Goals For Your Patients?

- Start treatment where the patient is, with an eye towards the skills they will need. Treatment may include:
  - Swallowing exercises to improve or maintain aero-digestive tract requirements for strength, speed, endurance, etc.
  - EMST to improve cough strength or other strategies for improving oral and pulmonary hygiene, including airway clearance techniques and PEP device use.
  - Vocal function exercise or RMT to improve or maintain endurance, and ROM in the speech, breathing and laryngeal muscles for high and low demand voice use.

What are the pre-requisites to swallowing safely?

What are the pre-requisites for voice use beyond a sustained /ah/ in low and high demand settings?

## What Are Goals for Your Patients?

### Research

- The respiratory system may have a regulatory function related to swallowing. Swallows near the E-I transition would have lower DPsub. (Gross Dysphagia 2012)
- Swallows typically occur during the expiratory phase of respiration with an obligate pause in breathing to accommodate swallowing. (Martin-Harris 2012)
- Swallow safety as defined by improvement in PA score improved post EMST in PD patients. (Troche et al 2010)
- Aspiration pneumonia is a multifactorial condition; aspiration alone not solely sufficient to develop aspiration pneumonia. (Langmore 1998)

### Treatment Goal/s

- Teaching patients to swallow at a higher lung volume may improve MIP and facilitate expiratory airflow and airway clearance.
- Patients might be trained to produce an optimal respiratory-swallow phase pattern.
- Employ EMST for improved hyolaryngeal complex movement.
- Employing airway clearance techniques after meals may serve to “sweep” debris from the lungs and reduce risk of developing aspiration pneumonia.

## What Are Goals for Your Patients?

### Research

- Swallows initiated near the E-I transition may be the most likely to result in bolus aspiration. (Paydarfar,D, et al 1995)
- Physiologic demands of swallowing deviate from single, small bolus swallows to sequential swallowing and competition for respiratory resources may increase. (Wheeler, JSHR, 2011)
- EMST may help strengthen respiratory muscles for cough , improved lung function, and endurance for swallowing (Kim/Sapienza 2005)

### Treatment Goals

- Diet modifications & monitoring bolus volume to optimize temporal coordination of swallowing.
- RMT for improved diaphragmatic breath support and timing of breathing and swallowing.
- Pursed lips breathing or other controlled breathing exercise to reduce work of breathing.
- EMST for improving MEP, peak flow, cough effort, and as preventative exercise.

RMT For Improved Timing of Breathing and Swallowing: 787.22 with PEG s/p CVA with severe oral apraxia and > 2years of dysphagia treatment. (Video 3)

Is pulmonary hygiene a missing piece?

Can your patient accommodate a compensatory strategy?

# The Perfect Storm

**Before: Patients Need Prevention Strategies and Exercise**

**After: Patients Need Restoration of Function and Pulmonary Hygiene**

# Putting It Together: Case Review

## Charles

- **History**: Parkinson's x 7 yrs. with orthostatic hypotension; s/p carotid endarterectomy 1/2012 with admit to rehab; falls in rehab; multiple re-admissions to the hospital; diagnosis aspiration pneumonia 6/12 with PEG placement.
- Discharged home Sept of 2012 with no further SLP tx. Patient and spouse were told he would never resume a po diet.
- MBS completed 11/2012 at hospital : "moderate-severe" oral-pharyngeal dysphagia. **Aspiration of all liquid consistency types with pharyngeal pooling documented. Amount of aspiration not quantified.**
- **Recommend: NPO**

## Case Review: Charles

- **Referral to Voice Aerobics: 11/20/12**
- The patient reported being "afraid of swallowing," including saliva, which he allows to pool orally. **Upon request, he was able to generate a volitional saliva swallow.**
- **Clinical findings**: oral-pharyngeal dysphagia more by report than clinical observation. Video-swallow findings appeared disproportionately severe to clinical presentation and general state of health.
- **Volitional swallow, reflexive and volitional cough serving some airway protection.**

Is pulmonary hygiene the missing piece?

- Enrolled in direct dysphagia treatment 3x's/wk with a long term goal of transitioning the patient to safe oral intake.

## Charles - Initial Short Term Goals

- Daily use of a resistive respiratory muscle trainer (follow **video-taped instruction)** for improved timing of respiration and swallowing; improved ability to increase lung volumes before the swallow; improved ability to "hold breath" during the swallow.
- Perform laryngeal strengthening exercises to improve hyo-laryngeal elevation and airway protection.
- Tolerate ice chips and water sips without s/s of aspiration, and implement the Frazier Free Water protocol, oral hygiene pre/post trials. Advance po trials as tolerated.
- Take temperature in the am to monitor any change in pulmonary status.
- **Pt goal**: to be able to eat and drink normally.

# Charles MBS 1/03/2013 (Patient's Birthday)

- Patient participated in a mobile MBS study 5wks post commencement of tx. Pt's wife present and observed the study.
- MBS study confirmed improvements in swallowing observed during the treatment period, and included:

➢ **Safe oral-pharyngeal transfer**, for nectar, thin liquids, and pureed consistencies.

➢ One episode of silent aspiration post swallow of regular consistency secondary to pyriform residue.

Patient participated in approximately 60 more days of tx.

# Charles Discharge Summary

**Summary Of Functional Outcomes Achieved From Evaluation:** 11/20/2012 **To Discharge:** 3/07/2013. **NOMS: Swallowing Level 5 ( prior level 1)**
**Response to Treatment:**

➢ **Repeat MBS 2/21/2014:** oral-pharyngeal dysphagia resolving, and patient tolerating regular soft diet **with no overt s/s of aspiration.**

➢ Continued use of IEMT device (The Breather®) 2 times/day and before bedtime for pulmonary hygiene.

➢ Perform oral hygiene independently.

➢ Tolerate water and other thin liquids and medications whole.

**(PEG removed 4/2013)**

**In Summary:** Airway clearance techniques and RMT can be integrated in SLP treatment to help patients:

- Improve breathing patterns for speech and swallowing.
- Mobilize secretions in lower airways and promote cough and clearance to reduce aspiration risk, or minimize aspiration effects.
- Improve diaphragmatic breathing for higher lung volumes and improved timing of breathing and swallowing.
- Improve respiratory muscle use and strength in patients with chronic and acute pulmonary, neuromuscular and neurodegenerative diseases.

**In Summary: Breathing exercise can have a profound impact on our physiology and our health.**

- "You can influence asthma; chronic obstructive pulmonary disease; and heart failure. People who practice breathing exercises and have those conditions benefit." (Mladen Golubic, MD Cleveland Clinic Center for Integrative Medicine)
- In 2010, the cost to the nation for COPD was projected to be approximately $49.9 billion, including $29.5 billion in direct health care expenditures.
- Beckerman et al documented that 1 year of IMT decreases utilization of health care services and suggested this may assist in reducing the overall economic costs.

## In Summary:
## Airway Clearance Techniques and RMT

- Regardless the device or technique you select, ***the patient is the variable.***
- Future research may help to identify the best candidates for specific device training and the best training regimen to optimize function and progression of training.
- To make the jump from research to practice we need to insert some values:
  - Those of the patient
  - Those of the professional
- "The question faced by clinicians, is not whether a therapy works, on average, but whether it will work on the patient at hand"
  (Tonelli,2001)

- ***"The correct choice may be a strategy, exercise, or device intervention that is clinically and cost effective, and preferred by the patient so that adherence can be at the very least supported.***
  "(Respiratory Care 2007)

"Calm breathing may boost production of alpha brain waves and put you into relaxed and alert zone." Dr. Oz

# Thank You For Your Attention

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## Airway Clearance and Respiratory Muscle Training Resources and Guidelines

- **ATS Statement: Guidelines for the Six-Minute Walk Test** THIS OFFICIAL STATEMENT OF THE AMERICAN THORACIC SOCIETY WASA PPROVE DBY THE ATS BOARD OF DIRECTORS MARCH 2002. AMERICAN JOURNAL OF RESPIRATORY AND CRITICAL CARE MEDICINE VOL 166 2002
- **ATS/ERS Statement on Respiratory Muscle Testing.** JOINT STATEMENT OF THE AMERICAN THORACIC SOCIETY(ATS), AND THE EUROPEAN RESPIRATORY SOCIETY (ERS) WAS ADOPTED BY THE ATS BOARD OF DIRECTORS, MARCH 2001AND BY THE ERS EXECUTIVE COMMITTEE, JUNE 2001
- Strickland SL, Rubin BK, Drescher GS, Haas CF, O'Malley CA, Volsko TA, Branson RD, Hess DR, American Association for Respiratory Care, Irving, Texas. **AARC clinical practice guideline: effectiveness of nonpharmacologic airway clearance therapies in hospitalized patients**. Respiratory Care 2013 Dec;58(12):2187-93.
- **Borg Rating of Perceived Exertion Scale** (Centers for Disease Control and Prevention) http://www.cdc.gov/physicalactivity/everyone/measuring/exertion.html

## Respiratory Muscle Trainers and PEP Devices/Websites

- Acapella® Vibratory PEP therapy. Smiths Medical http://www.smiths-medical.com/
- The Breather® inspiratory-expiratory flow resistant respiratory muscle trainer manufactured by: PN Medical. Distributed by: AliMed http://www.alimed.com and Voice Aerobics http://www.voiceaerobicsdvd.com/
- EMST-150® calibrated expiratory muscle trainer manufactured by: Aspire http://www.emst150.com/
- Expand-A-Lung® inspiratory-expiratory flow resistant respiratory muscle trainer. Order direct from manufacturer: http://www.expand-a-lung.com/
- Flutter® Cardinal health http://www.cardinal.com/
- PowerBreathe® and PowerBreathe® kinetic downloadable. www.powerbreathe.com
- Power Lung http://www.powerlung.com/
- Resistex® PEP therapy device manufactured by Mercury Medical http://mercurymed.com/home/
- Threshold® IMT and Threshold® PEP Manufactured by Phllips Respironics **http://threshold.respironics.com/**

## Airway Clearance Systems

- Vest® Airway Clearance System www.Vest.com
- Cough Assist® (Exsufflator) Manufactured by Respironics http://coughassistt70.respironics.com/ Insurance information, medical necessity information and ICD-9 codes can be found on their website.

## Airway Clearance and Active Cycle of Breathing (may re-print with permission)

*See separate handout*

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The **active cycle of breathing** technique is used to clear secretions. There are three parts to it:

**Breathing Control- Deep Breathing Exercises –Huffing**

**Breathing Control**: Airways are very sensitive and can feel tight and wheezy especially after coughing or when you are breathless. Breathing control is used to **relax the airways** and relieve these symptoms.

Rest one hand on your stomach and allow your shoulders to drop down. Breathe quietly and gently. As you breathe in your stomach should rise slightly, it should fall as you breathe out – do not force the air out. (Emphasize I :E ratio of 1:3 i.e. breathe out approximately twice as long as breath in)

## Deep Breathing Exercise

Deep breathing is used to get air behind the sputum stuck in small airways.

**Relax your upper chest, neck and shoulder muscles**

Breathe in slowly and deeply and breathe out gently through **pursed lips** until your lungs are empty.

Feel your abdominal muscles support the breath out.

Repeat 3 – 4 times. If you feel lightheaded go back to relaxed breathing. Purse lip breathing helps open and stent the small airways.

# Huffing

The Huff technique helps to avoid small airway collapse that occurs with elevated pleural pressures of strenuous coughing. Huffing moves sputum from the small airways to the larger airways, from where they are removed by coughing. Coughing alone does not remove sputum from small airways.

Instruction to patient:

- Take a medium sized breath in through the nose, squeeze the breath out by contracting your tummy muscles and keep your mouth and throat open (ha,ha,ha without voice). The breath should be prolonged, but don't continue until the lungs are empty.
- Take a large breath in, squeeze the air out as before, and cough and expectorate any sputum. If you don't produce any sputum with 1 or 2 coughs, try to stop coughing by using your breathing control.
- Allow your breathing to settle with breathing control and then repeat the cycle until your chest feels clear.

## Low resistance PEP device added to huffing may:

- Improve strength of the diaphragm, and thoracic and abdominal muscles used during inspiration-exhalation.
- Increase intra-thoracic pressure during the expiratory phase, which will decrease premature small airways closure (similar to pursed-lip breathing).
- Facilitate airway resistance, decrease WOB, decrease SOB, decrease RR, increase tidal volume and gas exchange.

(Follow manufacturer recommendations for specific device use.)

## Lo Tech Breaths

**Lo Tech Breaths**: Use a party favor and instruct the patient to blow 3 **slow breaths**, exhaling as long as you can, then inhale normally to replenish your breath. This is how you might use the breath during speaking. Focus on relaxed upper body.

Blow **3 quick breaths** similar to how you engage the abdominal muscles for coughing. Repeat the cycle 3/3 5 times.