Respiratory Muscle Strength Training for Trach and Ventilator Dependent Patients

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Disclosures

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- Received an honorarium from KSHA.
- Full time, salaried employee at Specialty Hospital

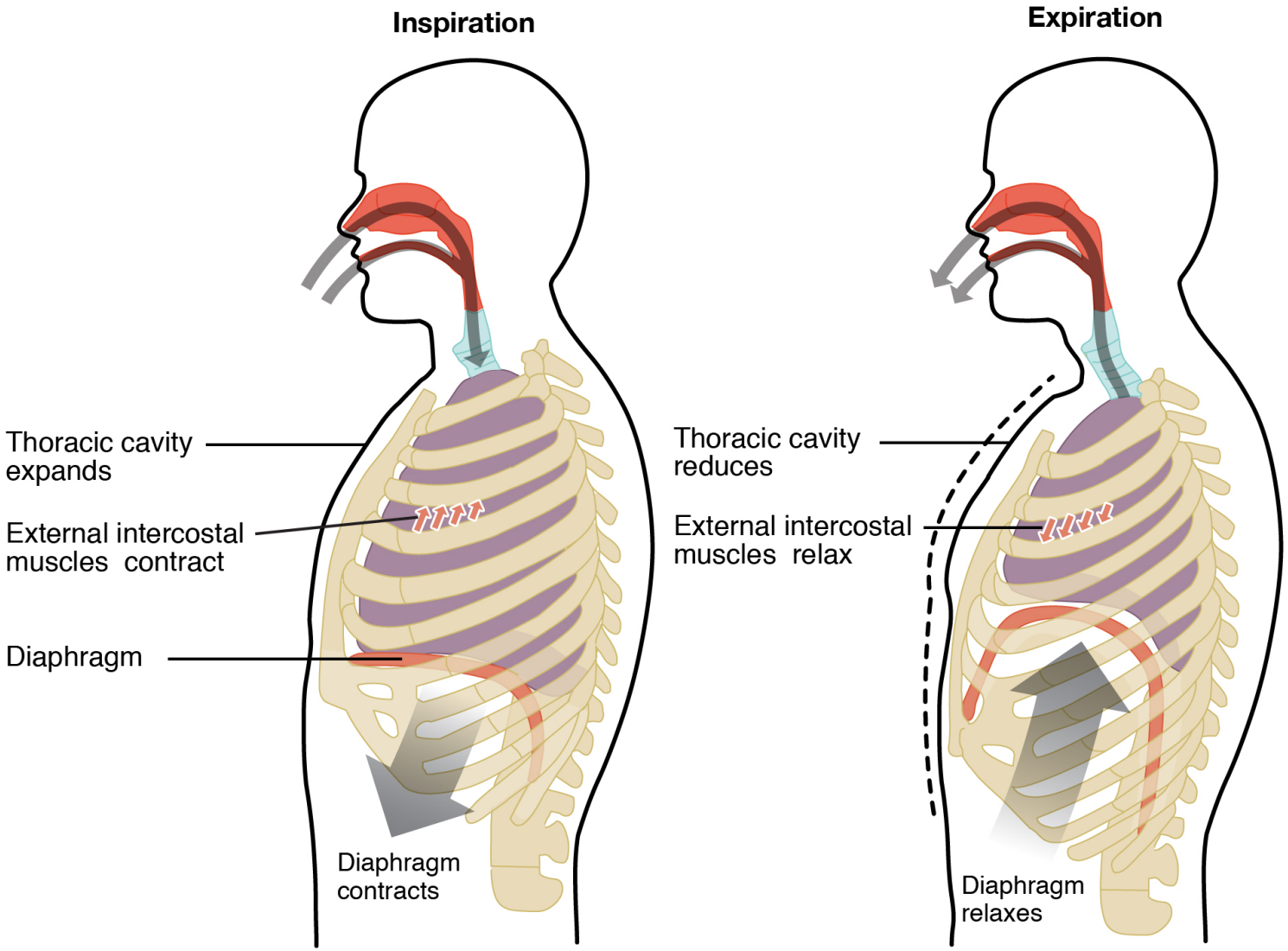
Objectives

- To understand the rationale and evidence base for the implementation of respiratory muscle strength training with patients with trach and vent dependence.
- To explain how to determine candidacy for participation in RMST for patients with trachs and vents.
- To understand how to implement RMST therapy with patients with trach and vent and how to measure functional outcomes.

What is Respiratory Muscle Strength Training?

- A treatment strategy aimed to strengthen the muscles of respiration by increasing their force-generating capacity (Troche, 2015)
  - Train muscles of inspiration (Diaphragm & External Intercostals) via Inspiratory Muscle Strength Training (IMST)
  - Train muscles of expiration (Abdominals & Internal intercostals) via Expiratory Muscle Strength Training (EMST)

Normal Respiration



Who can benefit from EMST

- Neuromuscular disease (PD, MS, ALS)
- Spinal Cord Injury
- COPD
- Stroke
- Sedentary elderly
- Trach / Vent patients

Effects of Tracheostomy and Ventilator Dependence

- Absence of airflow through the upper airway
- Swallowing impairments / increased aspiration risk
- Risk of vocal cord pathology
- Difficulty managing secretions / impaired cough strength
- General debility that affects respiratory musculature
- Comorbidities

Why RMST ?

- Shown to improve:
  - Cough
  - Voice
  - Speech
  - Swallow

RMST – started around the 1970's Populations studied:

IMST

- Athletes/general exercise (Cyclist, swimmers, rowers, runners)
- COD
- Diaphragmatic paralysis
- Obesity
- Upper airway limitations
- ALS, Myasthenia Gravis, Duchesne Muscular Dystrophy, Spinal Cord Injury
- Asthma

EMST

- Athletes, singers, navy divers
- Young and healthy
- Sedentary Elderly
- MS, PD, Myotonic dystrophy, stroke
- COPD
- Professional voice users
- Instrumentalists

Sapienza, C.M. & Troche, M.S. (2012)

Terminology

- MIP = Maximum Inspiratory Pressure
- MEP = Maximum Expiratory Pressure

- Indirect measure of muscle strength
- Measured with a manometer (cmH20)

Manometer

What is normal MIP /MEP? Adults 18-85

- Normal MIP
  - Men: -92 to -121 cmH20
  - Women: -68 to -79 cmH20
- Normal MEP
  - Men: 140 - 190
  - Women: 95 - 130
- Both higher in males and decline with age
- MEP lower than 30 cmh20 can lead to ineffective cough.

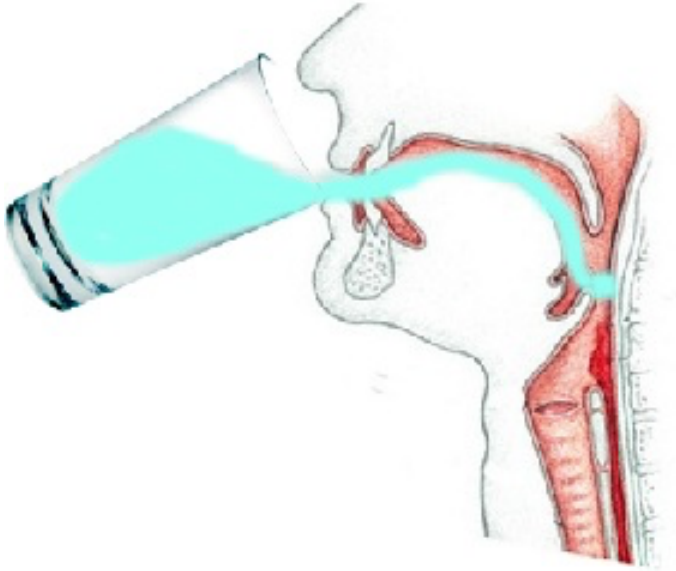
Enright et al., 1994 and Harik-Khan et al., 1998

Functional Outcomes-what does the evidence show?

- Cough Effectiveness
  - EMST and IMST improve maximum inspiratory and expiratory pressures.
  - Increase in force generating capacity translates to improved cough effectiveness.

References: Chiara et al., 2016; Kim et al., 2009; Pitts et al., 2009, Troche, 2015)

Swallowing function



- During EMST – increased activation of the submental muscles
- Increased movement of the hyolaryngeal complex during swallowing
- Both important for airway protection

Troche, M. ASHA perspectives 2015

Head & Neck Cancer

- EMST - Radiation associated aspiration (H&N cancer)
  - MEP's - reduced in 91% of aspirators compared to normative data.
  - MEP's improved 57% after EMST
  - Functional improvements in swallowing safety.

Hutchenson, K.A., et al. (2017)

Vocalists

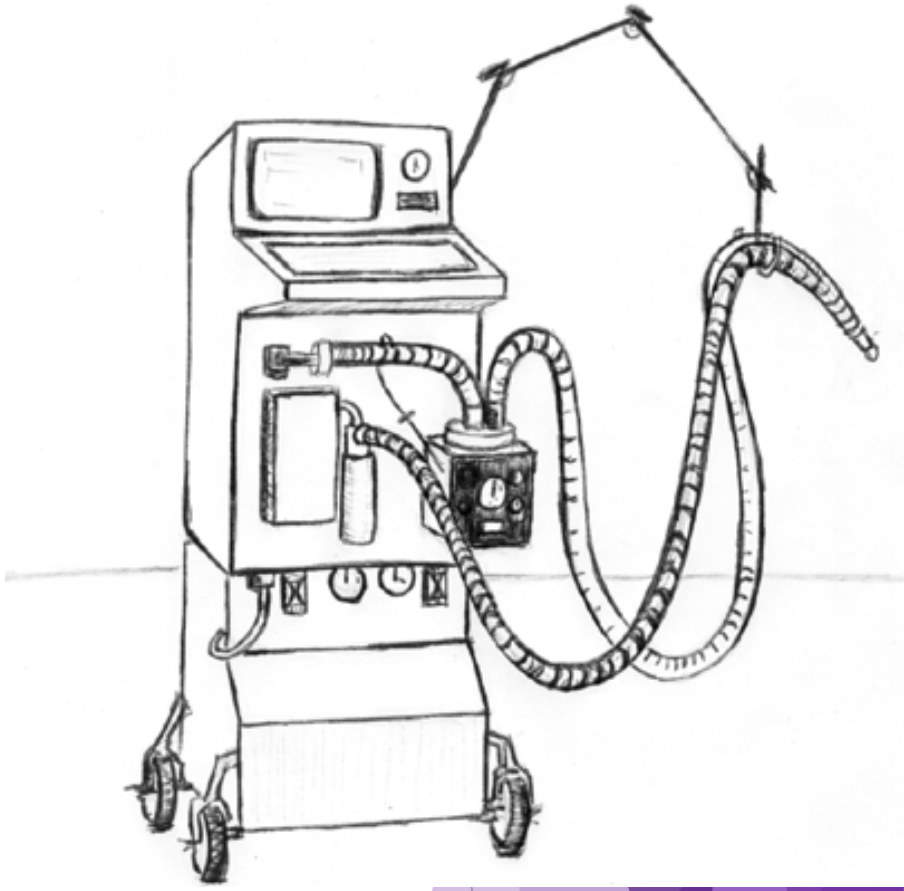
- Professional Singers and Musical Theatre Performers that trained with EMST demonstrated an 84% average increase in MEP
- Additionally, significant decreases in breathlessness and significantly longer durations for singing were observed.

The Effects of Expiratory Muscle Strength Training on Voice and Associated Factors in Medical Professionals With Voice Disorders. Tsai YC, Huang S, Che WC, Huang YC, Liou TH, Kuo YC.J Voice. 2015 Nov 10. Pii: S0892-1997 (15) 00212-X. doi: 10.1016/j.jvoice.2015.09.012.

Expiratory Pressure Threshold Training in High-Risk Performers. Hoffman-Ruddy, B., & Sapienza, C.M. (2001). Dissertation.

Vent Weaning

- IMST therapy with vent dependent patients
- MIP pressures increased by approximately 10cmH20
- Higher proportion of patients in treatment group weaned from mechanical ventilation.



(Martin et al., 2011)

Principles That Guide Strength Training

- Stimulus intensity – must be sufficient to elicit a change in muscle function.
- The target muscle group must be “**overloaded**” mechanically for strength training.
- Frequency / Duration

Sapienza, C & Troche, M, (2012)

RMST Devices

- **Resistive Trainers**
  - Have small orifices to breathe through that become progressively smaller as the treatment progresses.
  - Impacted by effort level and air-flow rate
- **Pressure Threshold Trainer**
  - Allows ability to “load” the system to provide resistance at quantifiable levels

Examples of Resistive Flow & Pressure Threshold Devices

Resistive flow device

Pressure Threshold Devices

How to measure effort level with a flow resistive device?

Photo credit: Voiceaerobics.com

Effectiveness of pressure threshold vs. resistance devices….what does research show?

- Study with IMST
- Both devices were effective
- Resistive trainer – difficult to determine whether the subjects were exercising at their target intensity. Could use manometer to monitor.
- Threshold: ensured consistency of training intensity.

Hsio, S.F. et al. (2003).

Can I use these devices for RMST?

Acapella

Incentive Spirometry

Airway clearance devices.

Airway Clearance Devices

- Devices designed to help patients maintain open airways (often after surgery).
- They have insufficient training resistance (Larson, Kim, Sharp & Larson, 1988)
- Strongly influenced by airflow rate
- Not appropriate for increasing respiratory muscle strength.

What if I don’t have access to a device?

- Straws of different sizes and shapes
- Use some of the airway clearance devices to start training – just be aware of limitations
- Whistles, noise makers with various size openings to blow through– cheap from dollar store – different levels of resistance (for low level patients – just starting)
- Blowing various objects across a table (cotton ball, ping pong ball, weighted ball – heavier the object, more effort is needed)

Inexpensive & Easily Accessible

RMST – How do I do it?

- Evaluate patient- what deficits are being treated?
- If possible, assess MIP and MEP
- Select a training device
- Implement an RMST training program. Start resistance at 70% of MEP /MIP

What if I don’t have a manometer?

- “Low tech” strategy for setting device
  - Not too easy…..not too difficult
  - Start at a low setting, have patient blow into device
  - Keep increasing pressure until they have difficulty moving air through device
  - Back off a bit until they can move some air through device

Training Inspiration vs Expiration…Which Direction?

Inspiratory Training (IMST)

- Can improve lung volumes- which can support swallowing
- May improve vocal cord opening
- Assist in weaning from vent

Expiratory Training (EMST)

- Improve cough strength
- Suprahyoid complex activation
- Vocal cord closure
- Breath support for speech
- Use mouth seal for weak labial seal
- (Note: Can do on SIMV, PSV Modes)

RMST - Train your patient

Inspiratory Training

1. Max exhalation
2. Open mouth
3. Place device in mouth, behind teeth
4. Seal lips around device
5. Inhale forcefully through device

Expiratory Training

1. Max inhalation
2. Open mouth
3. Place device in mouth, behind teeth
4. Tight lip seal around device
5. Hold cheeks (reduce buccal pressure)
6. Exhale forcefully through device

Think 5's

- Exact guidelines have not been established.
- One suggested protocol:
  - 5 sets of 5 repetitions, 5 days a week for 5 weeks
  - Start training at 70% of MIP and/or MEP (or use low tech strategy for starting point)
  - Use of nose clips

Sapienza, CM (2012)

Impaired Labial Seal

Disp-o-seal

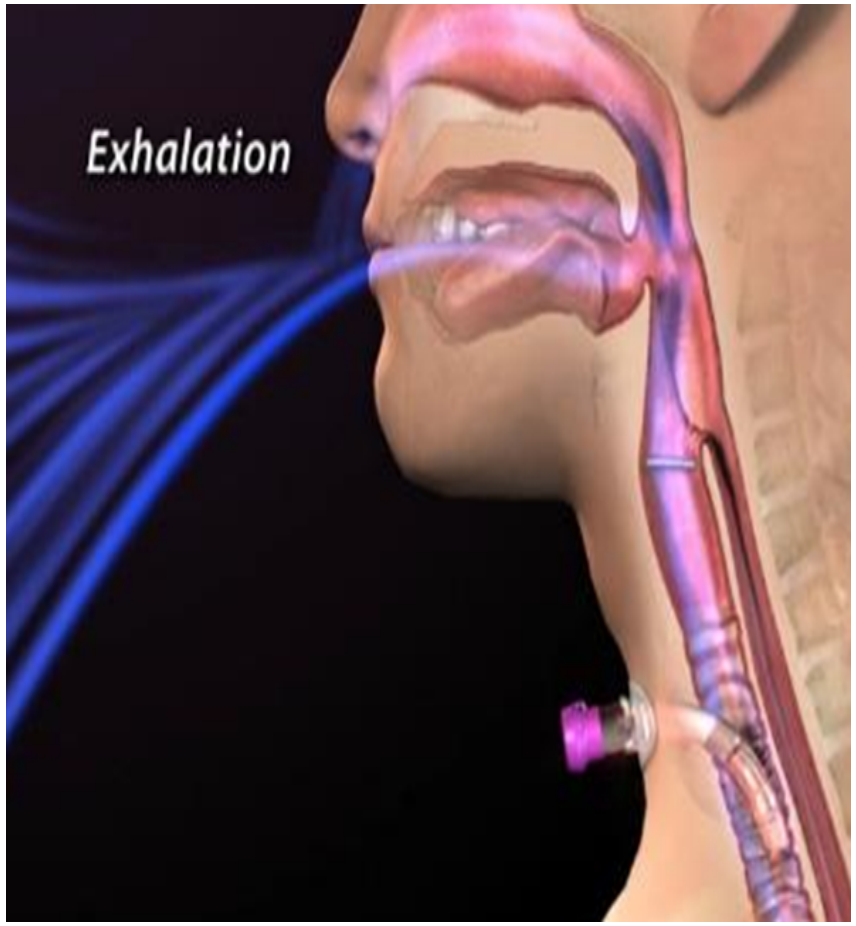
Vacuumed Tri-Seal

Groups where RMST is potentially contraindicated

- COPD
  - Mild to moderate cases-keep resistance at 50%
  - Close monitoring
- HTN/Hernia/Tachycardia/HTN/High RR
- Medical instability

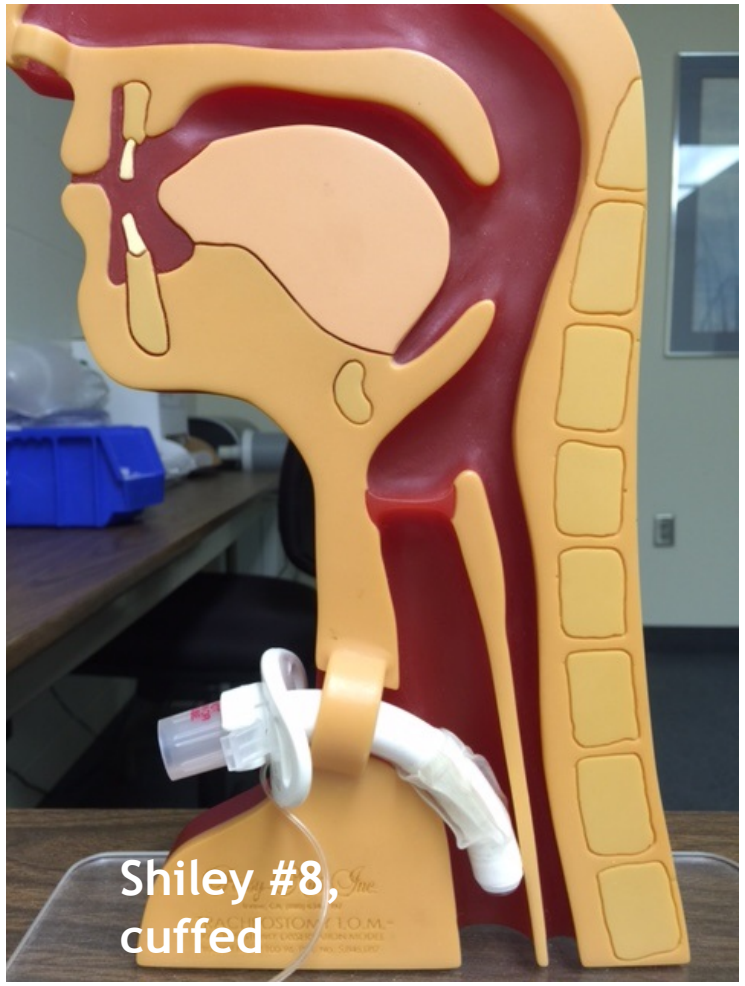
- Concern over EMST safety
  - Speech 5-10 cmh20
  - Cough 100-200 cmH20
  - Bowel movement 200-300 cmH20

Trach / Vent application - Restore Normal Physiology



- Use of a no-leak speaking valve to restore airflow through the upper airway.
- Allows evaluation of airway patency, voice quality, secretions management, cough strength.
- Troubleshoot any trach or airway issues

Troubleshooting Trach Issues with speaking valve use



May require trach downsize or different trach type.

Troubleshooting:
Air Leak around Stoma

Hydrophillic foam dressing

Silicone Pad

** May not be able to do RMST with a severe air leak

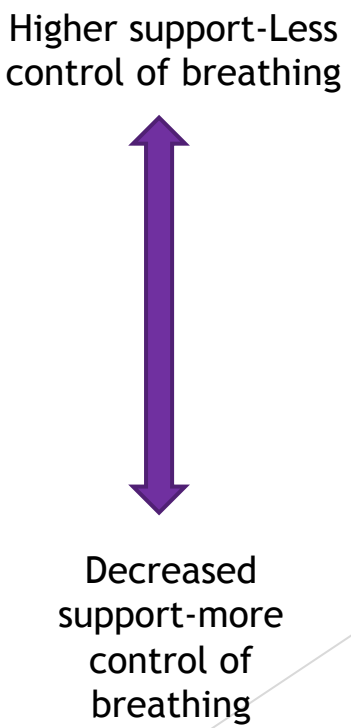
Mechanically vented patients can participate in RMST

Collaborate with respiratory care practitioner for in-line valve placement

Common Modes of Ventilation

- Assist Control (AC) (Higher Aspiration Risk)
- Sustained Intermittent Mandatory Ventilation (SIMV)
- Pressure Support (PSV)

  (spontaneous breathing)



Monitoring tolerance to therapy

- Pulse Oxymetry
- Resp Rate
- Work of breathing
- Patient Feedback

Data from ventilator

Respiratory Rate

Lung Volumes - IMST

Train to task

- Due to poor endurance, respiratory issues, cognitive deficits....may need to train patients to work towards therapy tasks.

Options for Measuring Outcomes

- Improvements in MIP /MEP
- Ability to inhale / exhale against increased pressure thresholds
- Penetration / Aspiration scale (pre/post instrumental assessment)
- Increased max phonation time
- Increased voice volume
- Changes in speech intelligibility

Detraining Effect & Maintenance

- Further research required to establish specific guidelines
- Once your goals for strength are achieved, you can reduced training frequency, intensity or duration and still prevent losses in strength gained for at least 12 weeks.
- However, must continue training with a maintenance program that still provides sufficient stress/load to the muscles.

Sapienza, CM 2015

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