EXPIRATORY MUSCLE STRENGTH TRAINING AS AN INTERVENTION ACROSS THE REHABILITATION POPULATIONS

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PURPOSE OF PRESENTATION

• Discuss general overview of expiratory muscle strength training (EMST)
• Identify appropriate candidates for use of EMST
• Describe the protocol, including strength training principles of EMST
• Review the literature supporting use of EMST
• Provide opportunity for hands on practice
• Present a case review
• Open forum questions & comments
WHAT IS EMST?

• What is EMST?
  – Forceful blowing
  – Maximum expiratory pressure (MEP)
  – Adjustable resistance
  – EMST150 device commonly cited in the literature

• What does it do?
  – Increase strength and coordination of the expiratory muscles
    • Voice
    • Cough
  – Activate the suprahypoid muscles
    • Swallow
      ❖ Hyolaryngeal elevation, airway protection, UES opening
EMST 150 PROTOCOL

- **Equipment**: EMST150 device, nose clip (as needed for those with velopharyneal dysfunction), stopwatch to monitor rest breaks between repetitions and sets

- **Frequency**: Studies support the use of EMST five days per week for between three and eight weeks
  - Other research suggests three days per week results in the same clinical outcomes and improves participant compliance
  - The EMST150 manufacturer recommends five days per week for five weeks, followed by three times per week for the ‘maintenance’ phase

- **Intensity**: Five sets of five repetitions at 60-75% of MEP, as set by the speech-language pathologist

- **Pacing**: Rest for a minimum of 15-30 seconds in between each repetition. Rest for a minimum of one minute in between each set

- **Time**: Training sessions should last a minimum of 20 minutes
**EMST 150 PROTOCOL**

- **Determining starting level**: While upright, participants are instructed to take a deep breath, hold their cheeks and lips lightly to prevent air escape, and blow with maximum speed and strength into the EMST150 device. If their expiratory force is sufficient to overcome the threshold pressure, they will hear air flowing freely through the device. Repeat this procedure until the MEP is found, consistent across three attempts. The starting level will be ~75% of the MEP (e.g. if 60 is the highest, then the target threshold will be 45), or another percentage as dictated by the SLP.

- **Progression**: The participant’s MEP may be assessed weekly. The MEP will then determine whether to maintain or increase the current pressure target.
MODIFICATIONS

• EMST150 equipment does not work with all patients
  – Inadequate lip strength
    ▪ Modified mouthpiece (now provided in EMST150 box)
    ▪ Manual lip closure
    ▪ Breathing mask
  – Inadequate expiratory force
    ▪ Cues for diaphragmatic breathing
    ▪ Cues to engage abdominal muscles
    ▪ Cues for correct posture
EMST & DYSPHAGIA
Who are the appropriate patient populations to use EMST, as it related to dysphagia? Literature supports its use for:

- Parkinson’s Disease
- Right and Left hemispheric stroke, both ischemic and hemorrhagic
- Multiple Sclerosis
- Huntington’s Disease
- Amyotrophic Lateral Sclerosis
- Head and neck cancer
- Geriatric patients
CONTRAINDICATIONS

• There are certain populations an SLP will want to confer with the physician prior to initiating use:
  – Recent decannulation
  – Lung transplants
  – Trouble maintaining adequate oxygen saturation

• What about cardiac issues or those with sternal precautions?
  – Research indicates that this is not a contraindication – (Laciuga, 2012)
Laryngeal elevation and excursion occurs as the suprahyoid muscles move the hyoid bone anteriorly, contributing to pharyngeal dilation.

Raising the larynx narrows the laryngeal inlet and moves it towards the pharyngeal surface of the epiglottis as the laryngeal cartilages move anteriorly.

The interarytenoid, aryepiglottic and thyroepiglottic muscles all involved in airway protection by closing in the manner of a drawstring purse.

Table 1: Swallow events tagged in relation to hyoid displacement measures*

<table>
<thead>
<tr>
<th>Event</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onset of bolus transit</td>
<td>Bolus head arrival at posterior edge of ramus of mandible</td>
</tr>
<tr>
<td>UES—opening</td>
<td>Forward displacement of cricoid cartilage from posterior pharyngeal wall</td>
</tr>
<tr>
<td>UES—widest</td>
<td>Widest part of bolus head passing through UES</td>
</tr>
<tr>
<td>UES—closure</td>
<td>Last point when UES is open</td>
</tr>
<tr>
<td>Laryngeal closure</td>
<td>Forward displacement of arytenoid cartilage to epiglottic petirole</td>
</tr>
<tr>
<td>Maximum laryngeal closure</td>
<td>Maximum contact of arytenoid cartilages with epiglottic petirole</td>
</tr>
<tr>
<td>Laryngeal opening</td>
<td>First separation of arytenoid cartilages from epiglottic petirole</td>
</tr>
</tbody>
</table>

Abbreviation: UES = upper esophageal sphincter.

* Definitions from Martin-Harris et al.

Shirley Ryan
Abililitylab
• Signs of dysfunction
  - Residue in pyriforms
  - Reduced UES opening
  - Reduced airway protection/closure
    • both from top down and bottom up
  - Penetration/aspiration
    • Resultant of reduced airway closure not coordination
WHAT DOES EMST DO FOR DYSPHAGIA?
LITERATURE REVIEW

Reduces dysfunction

• Strengthens suprathyroid muscle
  – Improves hyolaryngeal elevation, which assists in airway protection and UES opening

• Thyroarytenoid movement
  – Improves airway closure

• Changes in sensory function
  – Hegland determined sensory response for urge to cough increased with post training measures
    ▪ More research is needed to determine why this finding occurred

Changes in outcome measures

• Improved penetration-aspiration scale scores

• Improvements in FOIS and MASA
HOW TO SELECT THE CORRECT EXERCISE TO IMPLEMENT FOR IMPROVING DYSPHAGIA?

• Research has shown the efficacy of effortful swallows, Mendelsohn maneuver, and EMST on improved airway closure during the swallow. So, how do we prioritize which exercise to do in treatment?

• Principle of Task Specificity
  – Using specific exercise to improve specific targets
    • For example: effortful swallow to improve swallow strength
    • EMST is not task specific

• Principle of Task Overload
  – In order for a muscle to experience strength gains, it must be taxed beyond its present capacity to respond
    • Effortful Swallow and Mendelsohn Swallow: With the Mendelsohn maneuver and effortful swallow, the load imposed was volitional
    • EMST: Externally imposed threshold
EMST & SCI
Quadriplegia can damage the nerves innervating:
- Thoracic cavity
- Inspiratory and expiratory muscles
- Diaphragm
  - Phrenic nerve originates in C3-C5 and passes between lungs and heart to innervate diaphragm

Deficits may result in:
- Decreased efficiency of breathing
- Reduced tidal volume
- Reduced inhalation and exhalation volumes
- Reduced cough strength needed to mobilize secretions and promote pulmonary hygiene
COMPLICATIONS

• Medical
  – Atelectasis
  – Pneumonia
  – Choking
  – Early mortality
  – Voice disorders

• Social/Emotional (Ward, 2012)
  – Reduced volume
  – Vocal fatigue
  – Social isolation
  – Reduced participation in premorbid activities
APPROPRIATE SCI PATIENTS

• Patients with cervical and thoracic injuries (C4-T6) demonstrating
  – Altered respiratory muscle strength
  – Reduced secretion management
  – Reduced cough strength
  – Dysphagia

• Outcome measures used to assess baseline and progress
  – Tidal volume
  – Vital capacity
  – Maximum expiratory pressure
  – Decibel (dB) sound pressure level
• GB is a 60 y/o female diagnosed with suspected Guillian-Barre disease in December 2017

• Admitted to SRAL in January 2018 s/p doses of IVIG
  – Symptoms, as related to speech pathology, included decreased respiratory drive, decreased vocal intensity and breath support for conversational speech, impaired cough strength, and cranial nerve VII palsy
    • Mixed nerve with five branches, all seemingly affected

• Initial goals set for improving respiratory and vocal function, as well as a HEP for oral motor exercises (considered e-stim)
  – EMST150 device recommended for cough & voice

• Beyond reduced ROM of the jaw, no dysphagia initially flagged
  – Tolerating a general diet with thin liquids
• But then! Following week one of admission, GB began to regress, and suddenly she had limited to no function in her facial muscles
  – Unable to perform any labial movements, perform rotary mastication, or lateralize a bolus

• Downgraded to a puree diet with thin liquids
  – Confirmed tolerance of thin liquids via FSS
  – Also noted decreased strength needed for sustained airway closure
  – Considered G-tube placement, GB and husband not in agreement

• Speech intelligibility also severely impacted
CASE STUDY

• Goals modified to focus on dysphagia so that she can meet nutritional needs, especially in the setting of G-tube refusal
  – EMST to target previously identified goals of cough & voice but now also to target airway protection
• Road bumps
  – GB unable to create lip seal around EMST150 device or modified mouthpiece
  – GB unable to sense whether or not she was engaging her abdominal muscles and diaphragm
CASE STUDY

- RT suggested trialing a breathing mask, which fit nicely on the EMST150 device.
- Due to UE impairments, GB required two assistants to seal breathing mask to face and prevent air escape.
- Unable to elicit air emission at lowest level (15cmH20) for multiple weeks.
  - Received additional doses of IVIG in the meantime, and slowly she gained active ROM and sensation back.
- Eventually able to elicit air emission using this modified technique, reaching up to 30cmH20.
CASE STUDY

• Improved facial ROM, along with the ability to perform her EMST training according to the protocol, resulted in improvements to:
  – Cough strength, per GB report and subjective assessment
  – Vital capacity, as measured by RT
  – Hyolaryngeal elevation
  – Improved sustained phonation time, from 3 seconds to 16 seconds
  – Upgrade back to a general diet with thin liquids without the need for any strict aspiration precautions
  – FOIS from 5 to 7
  – MASA from 137 to 188
REFERENCES


