NHS
Sussex Community
NHS Foundation Trust

Using Expiratory Muscle Strength Training devices in people with mild MND

Melanie Rowe, November 2023

Advanced Speech & Language Therapist / Clinical Lead,
Community Neurorehabilitation Team South, Worthing

melanie.rowe2@nhs.net

Excellent care at the heart of the community

Content

- Define Expiratory Muscle Strength Training (EMST)
- Main findings of the EMST research in healthy & clinical populations
- Discuss emerging research in using EMST devices with MND
- Patient Case study

Types of Respiratory Muscle Strength Training Devices

Inspiratory (IMST)

PowerBreathe – Asthma & COPD

Expiratory (EMST)

Aspire EMST 150 and 75 Lite

Phillips Threshold Positive Expiratory Pressure trainer

EMST Published Literature

https://pubmed.ncbi.nlm.nih.gov/

306 Peer-reviewed publications

220 Randomised control trials (RCTs)

Groups Studied

Healthy People

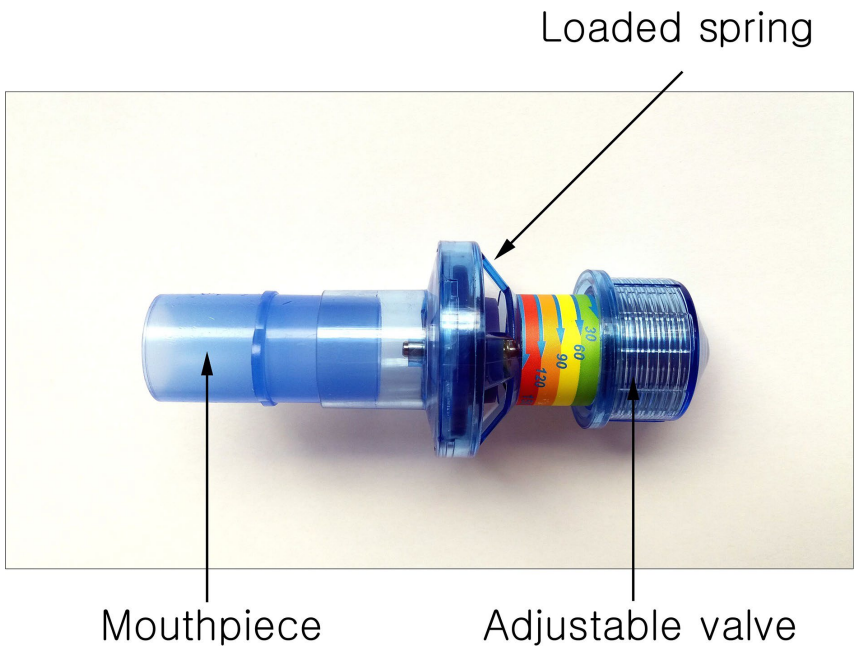
- Professional voice users
- Wind instrument players
- General Exercise
- Navy Divers

See Sapienza & Hoffman (2021) for an extensive review since the 1970 of healthy users of EMST

Neurological

- **MND** ***(Plowman 2016, 2018 & 2023)***
- Parkinson's *(Troche 2010, RCT)*
- Stroke *(Park 2016, RCT)*
- Multiple Sclerosis *(Chiara 2006)* Myotonic Dystrophy *(Allen 2020)but* no RCT's yet

EMST targets muscle strength



- One-way spring-loaded valve with an adjustable external pressure dial
- Pressure load (cmH_2O)
- Maximum Expiratory Pressure (MEP)
- Pressure load can be increased progressively throughout the training

EMST targets muscle endurance

- 5 breaths per set, 5 sets, total 25 breaths
- 5 Days a week
- Work for 5-12 weeks
- Maintenance programme as detrianing effect found in PD *(Saleem 2005)*

See Sapineza & Hoffman 2021 Protocol

Not Resistive Trainers

The Breather (PN Medical)

The Expand-a-Lung Breathing Fitness Exerciser

- Small holes to breathe through rather than a pressure valve
- Not calibrated
- Air-flow not strength
- No peer-reviewed publications regarding patient outcomes with these two devices, despite commercial claims

Respiratory Muscles targeted

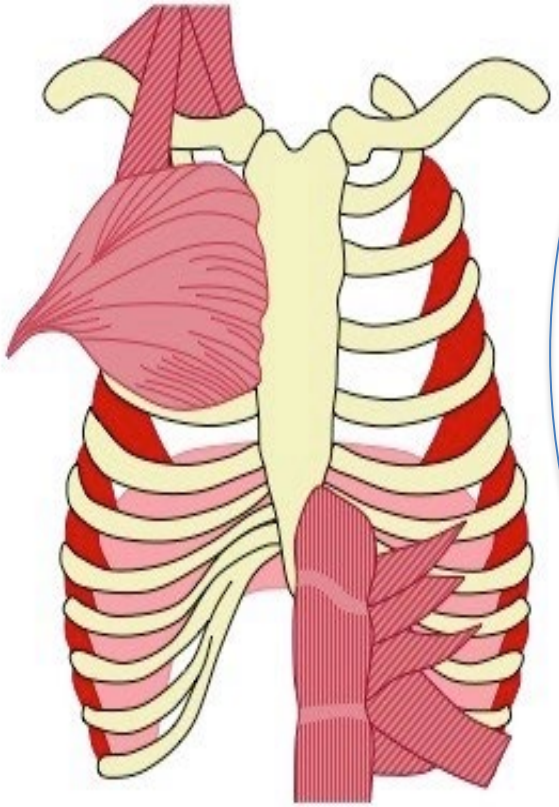
Muscles of Inspiration

Core Muscles

- External intercostals
  (contracts to elevate ribs)
- Diaphragm
  (contracts to expand thoracic cavity)

Accessory Muscles

- Sternocleidomastoid
  (contracts to elevate sternum)
- Pectoralis minor
  (contracts to pull ribs outwards)



Muscles of Expiration

Core Muscles

- Internal intercostals
  (contracts to pull ribs down)
- Diaphragm
  (relaxes to reduce thoracic cavity)

Accessory Muscles

- Abdominals
  (contracts to compress abdomen)
- Quadratus lumborum
  (contracts to pull ribs down)

Not just respiratory muscles!

Cough strength

Increases in Maximum Expiration Pressure (MEP)

(Menzes 2016, Myeong-Rae 2016 & Borders 2023)

Swallowing muscles
Suprahyoid complex

(Pauloski 2022 & Park 2016, Hutcheson et al 2017)

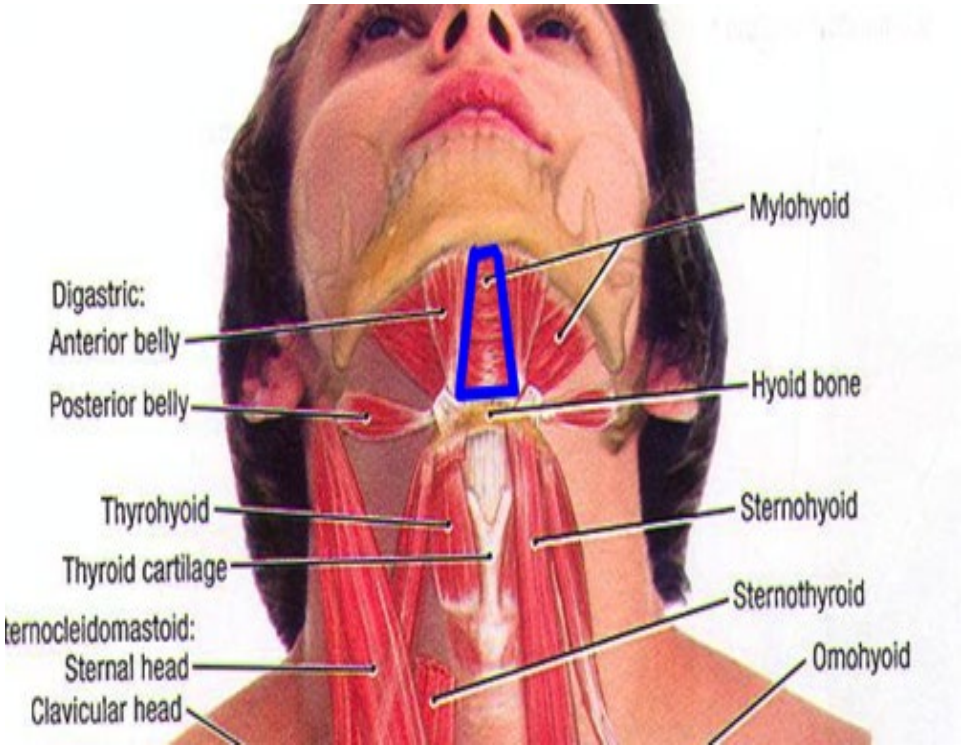
Glottic closure & airway protection

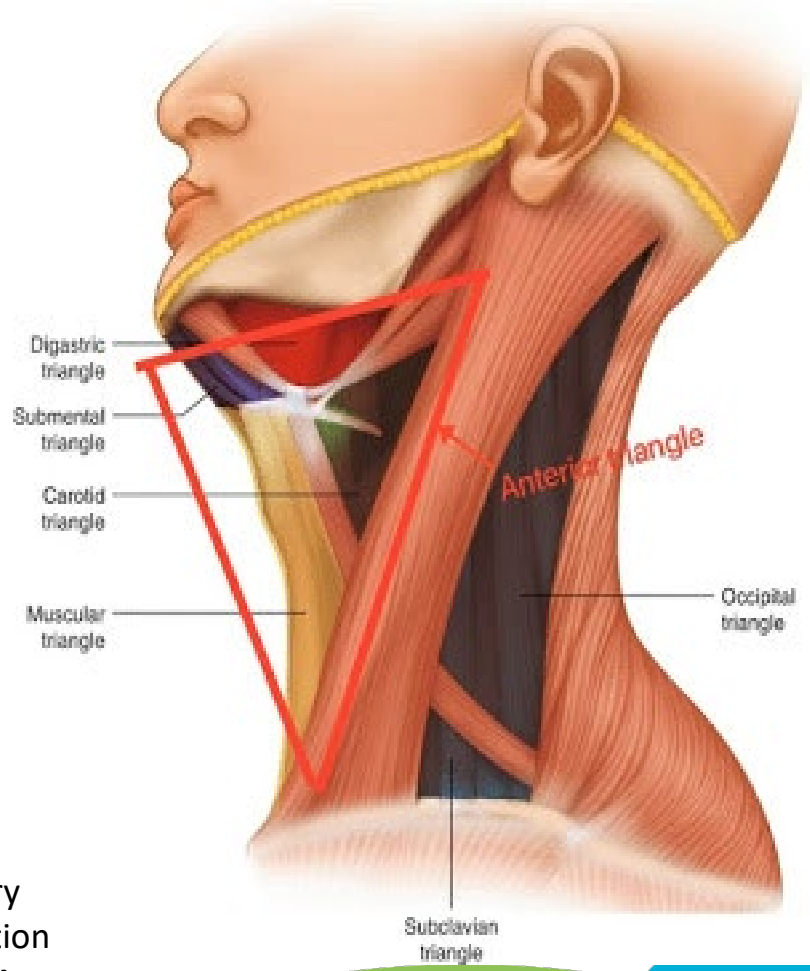
(Troche 2015; Hoon Mood et al 2017, Park 2016)

Orbicularis oris muscles

(Park & Oh 2016)

High resolution manometry and electromyography show EMST activates muscles of the hyolaryngeal complex





Hutcheson, KA, Harmer, Rosen, Jones, McCilloch (2017) Expiratory muscle strength training evaluate with simultaneous high resolution manometry and electromyography. Laryngoscope 127(4) 797-804.

What evidence & effect does using a EMST device have in pwMND?

Maximum Expiratory Pressure (MEP)

MEP reflects strength of expiratory muscles

Cough capacity / Airway clearance

MEP normative data for age & gender

Feasibility Clinical Controlled Trial: Plowman et al 2016

- 25 pwMND
- 5 week protocol
- Sham vs real
- 50% intensity load of their MEP
- MEP ranges at baseline were 12 – 122 cmH_2O

Outcomes studied:

- Maximum Expiratory Pressure (MEP)
- Hyoid displacement via VF
- Penetration Aspiration Scale via VF
- Cough Spirometry

Plowman et al (2016) Impact of Expiratory Strength Training in Amyotrophic Lateral Sclerosis. Muscle and Nerve 54(1)48-53.

Outcomes in 2016

Well tolerated no reports pain, discomfort etc.

MEP significantly increased by 29% in EMST group, compared to 9% reduction in sham group

75% EMST patients increased baseline MEP by 15%

Hyoid displacement during swallowing significantly increased, more efficient swallow

Penetration Aspiration scores no significant difference

Cough Spirometry scores no significant differences

RCT - Plowman 2018

- 48 pwMND
- 8 weeks
- 50% intensity MEP
- MEP baseline range, 14 – 107 cmH_2O

Outcomes studied

- MEP
- Cough spirometry
- Swallowing
- Forced Vital Capacity
- ALS Functional Rating Scale-Revised (ALSFRS-R)

Plowman et al (2018). Impact of Expiratory Strength Training in Amytrophic Lateral Sclerosis: results of a randomized sham-controlled trial. Muscle Nerve

Outcomes – 2018

- Well tolerated, no adverse events
- MEP: significantly increased by 25% in EMST group
- Swallowing: Little to no change in treatment group, while sham group worsened
- Cough spirometry: Peak Expiratory Cough flow remained stable 0% at change in EMST group, while 1% deterioration in sham group
- No differences in Forced Vital Capacity, ALSFR-R Scale (?sufficient length of time till reviewed @ 2 months)

RCT – Plowman 2023

- 45 pwMND
- IMST & EMST
- 12 weeks
- 30% MEP intensity
- Followed up at 1 year

Plowman et al (2023) Respiratory Strength Training in Amyotropic Lateral Sclerosis. A double-blind Randomized, Multicenter, Sham-Controlled Trial. Neurology. (100) 1634-1642.

Outcomes studied

- MIP
- MEP
- Cough spirometry
- Forced Vital Capacity
- Global & Bulbar decline on ALSFRS-R
- Time to NIV

Results 2023 - Primary Outcomes

MEP in EMST group **increased significantly** by average 20.8cmH2O, while it decreased 1 cmH2O in sham group.

No MIP differences observed between groups (?intensity at 30% too low)

Results - Secondary measures
Cough Spirometry

Cough Peak Inspiratory (PIF) **improved** by 62.5 l/min in active group, while sham group it decreased by 1.31 l/min

Cough Peak Expiratory Flow (PEF) **improved** by 35.1 l/min in active group, while sham it decreased by 24.0 l/min.

Results 2023 - Follow-up Measures

ALSFRS-R Bulbar scale slope, two-fold faster decline in the sham group vs the EMST group

The ALSFRS-R total scale slope, and time to NIV did not differ across treatment groups

Is it safe to exercise pwMND with EMST device?

EMST training is mild intensity exercise

No adverse effects reported in current research

Poor MEP values in pwMND have a harmful effect on survival, ***in addition*** to larger effect of weak inspiratory muscles (Polkey 2017)

Light exercise & not overloaded. Train at adjusted value of MEP 30 – 50%

Speak need: 5 – 10 cmH_2O,

Cough need: 100 – 200 cmH_2O,

Bowel movement: 200 – 300 cmH_2O.

Choose the EMST device based on pwMND's MEP at baseline

MEP < 40cm H_2O

EMST 75 Lite

0 – 75 cmH_2O

MEP > 40 cm H_2O

EMST 150

24 – 150 cmH_2O

Precautions & contraindications

Caution – seek advice

- Traumatic pneumothorax and/or broken rib
- CSF drain or intercranial pressure monitoring
- Recent facial, oral, neck, skull or chest including cardiac surgery
- Oesophageal surgery
- Lung transplant or resection

Contradictions:

- **Asthma & frequent exacerbations**
- **Ruptured eardrum**
- **Pregnancy**
- **Uncontrolled reflux**
- **Uncontrolled HT**
- **Recent abdominal hernia or recent abdominal surgery**

See Sapienza & Hoffman 2021 book for clinical application

Case Study
a pilot of the EMST in pwMND

Suitable MND candidates for EMST

Preserved cognition	Motivated	Hold device themselves
Reduced MEP age/gender	Peak Cough Flow 160 - 270 L/min	Sufficient seal with mouthpiece
Vital capacity > 65%	No NIV or trache	ALS FRS-R score > 30

Patient 1 - History

- 72 female, diag. March 2023, bulbar symptoms since 2021
- Mild MND – ALSFRS-R Score 40
- Item 1 Speech: 3
- Item 2 Salivation: 3
- Item 3 Swallowing: 3
- No Gastrostomy
- Probable COPD (ex-smoker)
- No NIV
- Highly motivated and interested in EMST research

Patient 1's Respiratory Results

Pulmonary Function Test	July 2023	October 2023	NICE Guideline (2016, 2019) reference values
CO_2	5.2	5.3	> 6kPa urgent referral
FVC	?	83%	< 80% and signs/symptoms or < 50%
SNIP (cmH_2O)	50	**48**	< 55 cmH_2O (in females)
PCF (L/min)	**150**	?	< 270 L/min
SPO_2	94	96	> 93 possible lung disease > 94 no lung disease

Patient 1 Baseline Assessment Measures

Maximum Expiratory Pressure (MEP) 51 cmH_2O	Norm expected 69.6 cmH_2O
Peak Cough Flow (PCF) 180 L/min	Norm expected 334 – 356 L/min 270 L/min (NICE MND)

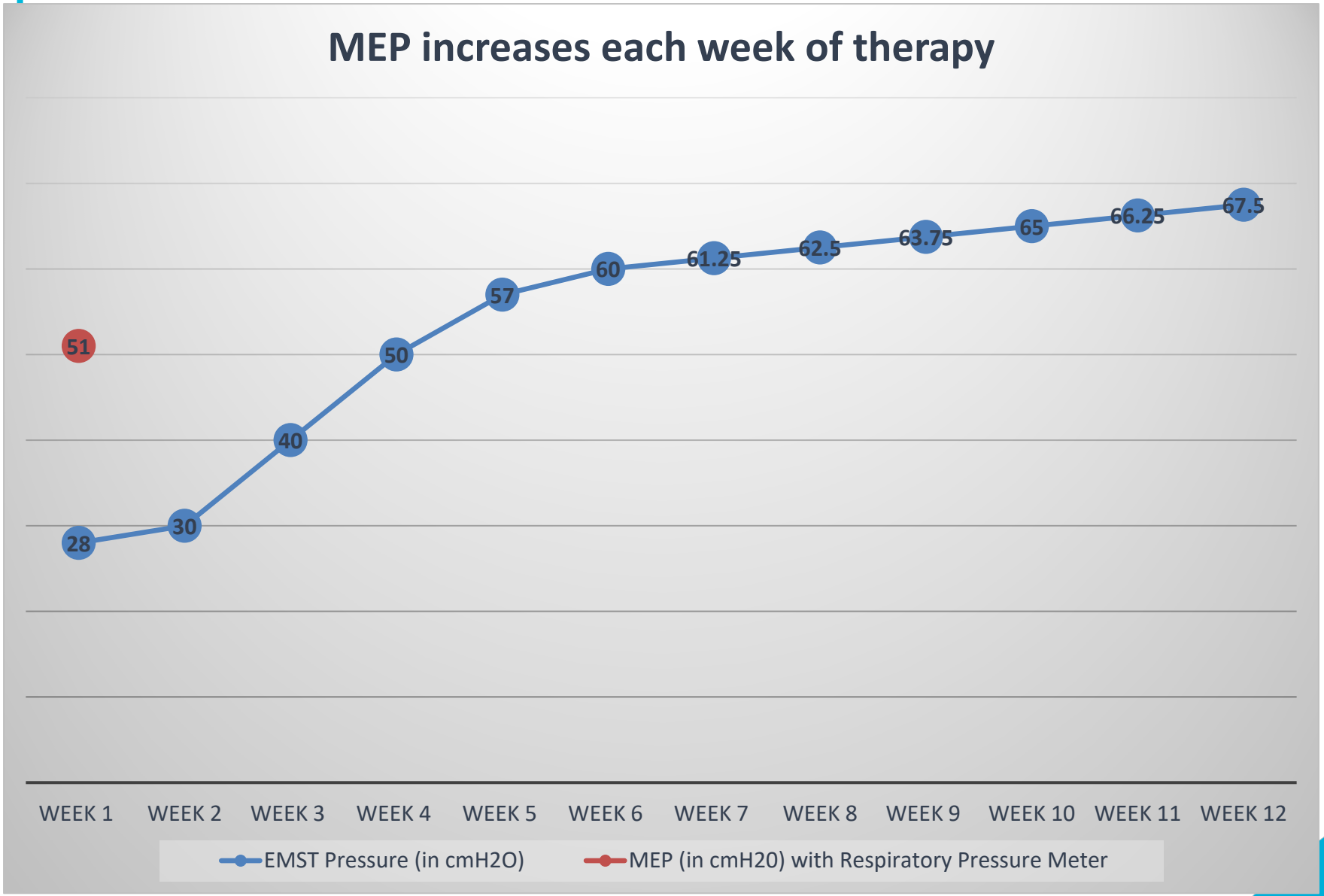
MEP therapy targets

25% increase of MEP value to **63.75 cmH_2O**

29% increase of MEP value to **65.79 cmH_2O**

Normative data gender/age: 69.6 cmH_2O

MEP increases each week of therapy



Findings so far

MEP progressively increased from baseline 51cmH_2O

67.5 cmH_2O is 30% MEP increase

(Norm 69.6)

Patient report: feels a strong cough to clear secretions & no new swallowing symptoms

What ALSFRS-R Bulbar scale scores

1 year follow-up

Quick intervention 30 mins

1:1 and remote

Considerations in NHS

Class II evidence that EMST training increases MEP in early stages of MND. MEP declines in those not using EMST. More research needed in long-term functional outcomes

Costs. EMST device £71 – 75

Prepare funding bids to the Sussex MNDA and SCFT League Of Friends

EMST device is Class I medical device. Inform medical devices & comply NHS Clinical Governance processes

Establish clinical support within the Respiratory Nurse & Physiotherapy networks

Training for SLT & our assistants vs Aspire course https://emst150.com/events/

References

References

- Troche MS, Okun MS, Rosenbek JC, Musson N, Fernandez HH, Rodriguez R, Romrell J, Pitts T, Wheeler-Hegland KM, Sapienza CM. Aspiration and swallowing in Parkinson disease and rehabilitation with EMST: a randomized trial. Neurology. 2010 Nov 23;75(21):1912-9. doi: 10.1212/ WNL.0b013e3181fef115. PMID: 21098406; PMCID: PMC2995389.
- Park, J S et al. “Effects of expiratory muscle strength training on oropharyngeal dysphagia in subacute stroke patients: a randomised controlled trial.” Journal of oral rehabilitation vol. 43,5 (2016): 364-72. doi:10.1111/joor.12382
- Chiara et al (2006) EMST in persons with MS having mild to moderate disability: effect on maximal expiratory ppressure, pulmonary function and maximal voluntary coufh. Archives of Physical medicine and Rehabilitation 87, 486-473.
- Allen, J., Astin, R., Smith,C., Banks, D., & Turner,C. (2020). “Expiratory muscle strength training improves measures of pressure generation and cough strength in a patient with myotonic dystrophy type 1" Neuromuscular Disorders, 30(9), 750-755.

References

- Sapienza and Hoffman (*2021)* Respiratory muscle strength training: theory and practice. San Diego Plural Publishing.
- Saleem, Sapienza & Okun (2005). Respiratory muscle strength training: treatment and response duration in a patient with early idiopathic Parkinson's Disease. Neurorehabilitation, 20, 323-333.

References:

- Menezes, Kênia Kp et al. “Respiratory muscle training increases respiratory muscle strength and reduces respiratory complications after stroke: a systematic review.” Journal of physiotherapy vol. 62,3 (2016): 138-44. doi:10.1016/j.jphys.2016.05.014
- Myeong-Rae, JO., Nan-Soo K (2016) The correlation of respiratory muscle strength and cough capacity in stroke patients. Journal Physical Ther Science. 28(10) 2803-2805.
- Borders, James C, and Michelle S Troche. “Voluntary Cough Effectiveness and Airway Clearance in Neurodegenerative Disease.” Journal of speech, language, and hearing research : JSLHR vol. 65,2 (2022): 431-449. doi:10.1044/2021_JSLHR-21-00308
- Pauloski, Barbara R, and Kacey M Yahnke. “Using Ultrasound to Document the Effects of Expiratory Muscle Strength Training (EMST) on the Geniohyoid Muscle.” Dysphagia vol. 37,4 (2022): 788-799. doi:10.1007/s00455-021-10328-x
- Hutcheson, KA, Harmer, Rosen, Jones, McCilloch (2017) Expiratory muscle strength training evaluate with simultaneous high resolution manometry and electromyography. Laryngoscope 127(4) 797-804
- Park, J S et al. “Effects of expiratory muscle strength training on oropharyngeal dysphagia in subacute stroke patients: a randomised controlled trial.” Journal of oral rehabilitation vol. 43,5 (2016): 364-72. doi:10.1111/joor.12382

References – Not just respiratory muscles continued

- Troche MD (2015) Respiratory Muscle Strength training for the management of airway protective deficits. Dysphagia 24(2). 58
- Hoon Mood, J et al (2017). Effects of expiratory muscle strength training on swallowing function in acute stroke patients with dysphagia
- Park, JD., Oh., DH., Chang, MY. (2016) Effect of expiratory muscle strength training on swallowing-related muscle strength in community-dwelling elderly individuals: a randomized controlled trial. Gerodontology (16)
- Hoffman R., Pitts T & Sapienza CM (2014) Improved voluntary cough immediately following office based vocal fold mediatization injections. Laryngoscope.
- Sapienza & Trocher (2012) in Sapienza and Hoffman (*2021)* respiratory muscle strength training: theory and practice. San Diego Plural Publishing.

References

- Combert, Y et al (2021) The relationship between maximal expiratory pressure values and critical outcomes mechanically ventalited patients: a post hoc analysis of an observational study. Annals of Intensive Care (11) 8
- Polkey, MI, Lyall, K. Yang E., Johnson, PN., Leigh, J., Moxham. Respiratory muscle strength as a predictive biomarker for survival in ALS. Ann J Respi Crit Care Med 195 (1) 86-95.
- Enright, PL., Kronmal, RA., Manolino, TA (1994). Respiratory muscle strength in the elderly. Correlates and reference values. Am J Resir Crit Care Med, 158:1459.
- Harik-Khan, RI, Wise, RA, Fozard, JL. (1998) Determinants of maximal inspiratory pressure: the Baltimore Longitudinal Study of Aging. Am J Resp Crit Care Med: 158: 1459

Training Videos - Aspire

- https://youtu.be/V6TdPWscTys

- **For upcoming course & webnairs. Run by Aspire see www.emst150.com**

MEP normative data

Age (Years)	Female (cmH2O)	Male (cmH2O)
20 - 29	114.1	147.3
30 – 39	100.6	140.3
40 – 49	85.4	126.3
50 – 59	83.0	114.7
60 – 69	75.6	111.2
70 – 80	69.6	111.5