EFFECTIVENESS OF INSPIRATORY MUSCLE TRAINING (IMT) IN PATIENTS WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE (COPD): A LITERATURE REVIEW

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Effectiveness of Inspiratory Muscle Training (IMT) in patients with Chronic Obstructive Pulmonary Disease (COPD): A Literature Review

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ABSTRACT:

Introduction: In chronic obstructive pulmonary disease (COPD) patients, there is respiratory muscle weakness and to train that muscle, there are various techniques present. One of the techniques of inspiratory muscle training (IMT) is using pressure threshold device. The use of this device is not well established and also there are a very few researches regarding IMT and COPD in India. So, this thorough literature search is conducted to extend the knowledge base regarding the effectiveness of inspiratory muscle training using pressure threshold device in COPD patients as it is less evident in India.

Methodology: By using various search engines - PUBMED, MEDLINE, GOOGLE SCHOLAR, RESEARCH GATE, CLINICALKEY, SPINGER, 30 articles were analyzed that were published in past10 years.

Result: 8-week of IMT in COPD patients shows the improvement in Inspiratory muscle strength & endurance, walking Distance measured with 6-minute walk test, Exercise Capacity, different scales of dyspnea. Improvement can be seen in all component but mainly Psychological & physical component of the Quality of life.

Conclusion: After reviewing the researches, the conclusion is, IMT in COPD patients improved the inspiratory muscle strength and endurance lead to less fatigue which improve the exercise capacity and dyspnea and due to that patient is having less restrictions in day-to-day life and hence improve quality of life and health status. So, this practice of inspiratory muscle training is recommended in pulmonary rehabilitation in COPD patients.

KEYWORDS: Chronic obstructive pulmonary disease, Inspiratory muscle training, Threshold device, Respiratory muscle weakness

INTRODUCTION:

Chronic Obstructive Pulmonary Disease (COPD) is a preventable and treatable disease that is mainly characterised by airflow limitation. It is the most common disease, mainly due to exposure to noxious particles or gases, and is influenced by host factors, including abnormal lung development. [1] In 2002, it was ranked 11th, and now it is projected to rise to 7th in the year 2030.[3] COPD is the second-biggest cause of death in India today.[2]

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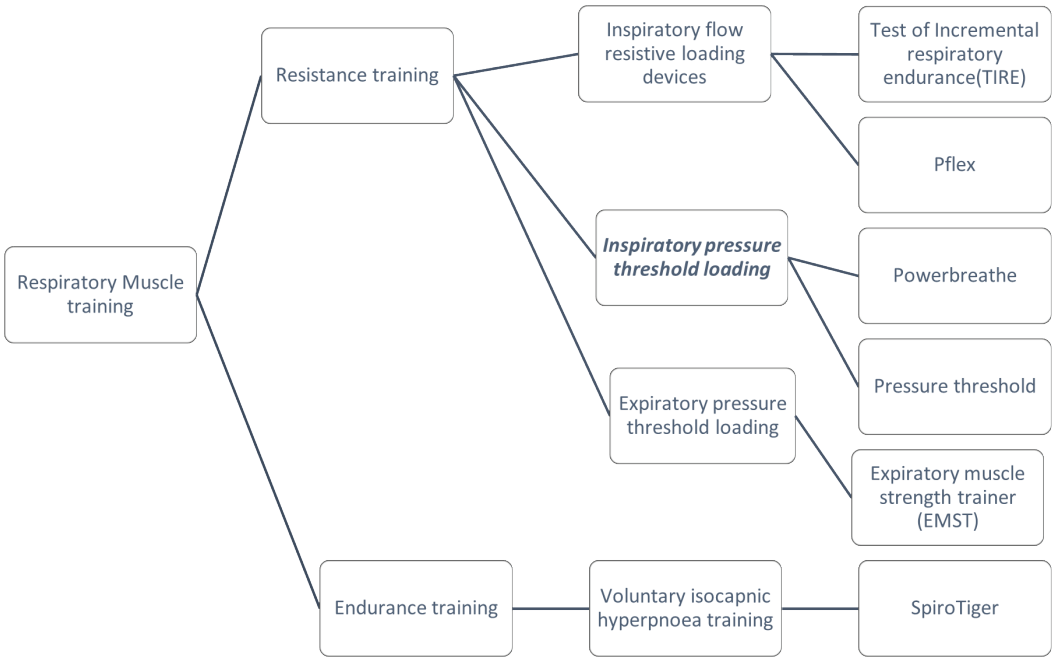
Muscle dysfunction in patients with severe COPD is characterised by reduced muscle strength and endurance.[3] Respiratory muscle dysfunction is due to hyperinflation of the lung or diaphragm, which flattens and shortens. This reduction in inspiratory muscle strength and endurance increases the risk of

hypercapnic respiratory failure, limited exercise, and acute exacerbation, despite diaphragm adaptation. [4] In acute exacerbations, there will be an additional increase in systemic inflammation with higher blood levels of C-reactive protein (CRP), cytokines (IL-6, IL-8, and TNF-alpha), leptin, endothelin-1, and fibrinogen, which can contribute to the deterioration of muscle function and probably affect both limb and respiratory muscles.[5] In pulmonary rehabilitation, the most common approach for Inspiratory Muscle Training (IMT) is to use devices that impose a resistive or **threshold load.**[6]

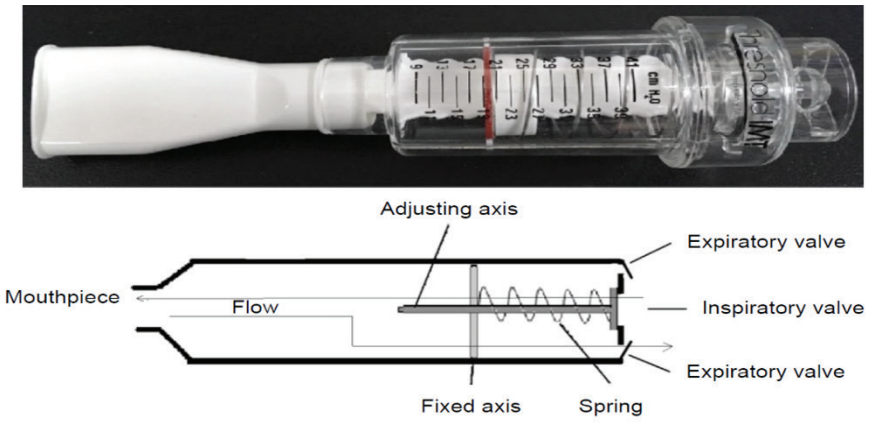
Figure 1: Respiratory muscle devices[6]



Respiratory muscle training (strength as well as endurance) devices are listed in Figure 1. IMT is a targeted strengthening of the inspiratory muscle through the application of resistance during inspiration. IMT with a threshold trainer increases inspiratory muscle strength, increases inspiratory muscle endurance, reduces dyspnea, and increases exercise tolerance and quality of life. [7] Threshold devices have superiority in improving inspiratory muscle strength over any other devices. [8]

These are parts of the IMT device (Figure 2):[9]

Figure 2: The parts of Pressure threshold device[9]



There are still doubts regarding IMT efficiency and its influence on exercise tolerance in patients with COPD. In India, a pressure threshold device is not widely used for the training of inspiratory muscles so there is a lesser number of qualitative evidence available which indicates the use of the device for COPD patients. Therefore, this literature review is to extend the knowledge base regarding the

effectiveness of inspiratory muscle training using the pressure threshold device in chronic obstructive pulmonary disease.

METHODOLOGY:

Prior to commencing the study, the study proposal was prepared and submitted to the "Institutional Ethics Committee" of the H. M. Patel Centre of Medical Care and Education, Karamsad, for its approval and permission to begin the study. (IEC/HMPCMCE/117/Faculty/8/177/20, dated on 26/08/2020).

Search strategy: A literature review was conducted using the following terms: 'COPD', 'Chronic Obstructive Pulmonary Disease', 'IMT', 'Inspiratory Muscle Training', 'Pressure Threshold Device', 'Respiratory Muscle Weakness', 'Respiratory Dysfunction', 'IMT device', 'Inspiratory Muscle Training Device', 'Respiratory Muscle Training'. The keywords 'COPD' AND 'IMT', 'IMT' AND 'Pressure Threshold Device', 'Pressure Threshold Device' AND 'Respiratory Muscle Weaknesses' were used for searching the review of the literature study.

The databases and search engines used included PUBMED, MEDLINE, GOOGLE SCHOLAR, RESEARCH GATE, CLINICALKEY, and SPINGER.

A total of 62 articles were reviewed, which were published from 2011 to 2020. The articles suggestive of IMT using the pressure threshold device in COPD patients were included. A total of 30 articles were selected. Each article was evaluated for its contribution to the body of literature related to IMT using the pressure threshold device, particularly in patients with COPD.

RESULT:

A total of 30 articles were reviewed; the main characteristics of the articles are described below:

- Effect of IMT on COPD patients
- IMT vs Sham IMT
- IMT vs Control group
- IMT vs Expiratory muscle training(EMT)
- IMT vs Resisted IMT(RIMT)
- IMT vs Calisthenic and breathing exercise
- Threshold vs POWERBreathe

Few of the articles share commonalities in the intervention section. So, here in the table, a comparison of 10 articles that indicate IMT in COPD is described.

Author/ Year/ Country	Inclusion criteria	Intervention	Outcome measures	Result	Conclusion
Han-Yu Chuang et al. 2017/ Taiwan [10]	-Stable condition - Forced Expiratory Volume in One Second (FEV_1) is less than 80% of the estimated value. & FEV_1/ (forced vital capacity) FVC<70% -Conscious & co-operated & able to express themselves	IMT Group- 8 weeks 5 sessions/week 21-30 minutes/ session 2-minute of inspiration with 1 minute rest 7 cycles/session (2 weekly incr eased load) Starting from 15 cmH_2O to 40 cmH_2O Control Group -Health Education and routine care	1.Maximal Inspiratory Pressure (MIP) 2.Baseline Dyspnea Index (BDI) 3.6-Minute walk Test (6MWT) 4.SF-36	Improvement in IMT group -MIP- 13 cmH_2O increased -BDI-more than 4 points increased -6MWT- 48m distance increased -SF-36 Physiological and psychological domain-improvement	In individuals suffering from moderate to severe COPD, the threshold IMT can improve prognosis by lessening everyday activity challenges for the patient, which lessens the burden on the family.

Author/ Year/ Country	Inclusion criteria	Intervention	Outcome measures	Result	Conclusion
Noppawan Charususin et al. 2018/ Belgium [11]	-Clinically stable COPD, -MIP<60cmH_2O	IMT Group- 3-5 sessions/week 60 minutes/session (20-36 sessions) 30 breathe/session Initially 50%MIP (weekly increased load up to highest tolerable intensity) (With moderate to high levels, endurance training or interval training) Control Group -10% MIP – not increased throughout the study period	1.6-Minute walk test 2. Strength and endurance of the respiratory muscles 3. Endurance cycling and Maximal exercise capacity 4.Pulmonary functions 5.Physical activity (objectively By Dynaport Minimond)	-Endurance cycling testing– improvements seen in IMT group -No difference in 6MWT -MIP- progressed from 47%±2% to 84%±4% -Forced Vital Capacity (FVC) increased in IMT group -larger improvements in inspiratory muscle strength in IMT group -Endurance breathing test – Improvements in time to the limit of tolerance, average mean power per breath and overall work in IMT group	Additional IMT did not show any improvement in the primary outcome of the 6-Minute Walk Distance (6MWD)., despite improvements in respiratory muscle function. Reduced dyspnoea symptoms and increased endurance time were found in a secondary outcome of an endurance cycling test.
Diogo Fanfa Bordin et al. 2019/ Belgium [12]	- Patients with COPD classified as being in stages II to IV by the GOLD classification A patient must be clinically stable, enrolled in a lung rehabilitation program for at least two months, and have given their informed consent.	IMT Group – 8-weeks (Respironics)- Education and training - 1st week- 3 sessions (20 minutes each) familiarization - without resistance -Up to 4 week- 3 times/week for 20 min. -5th& 6th week –25 min -7th&8th week - 30 min (load-50%-MIP-weekly increases load) Control Group – 30 minutes- cycle ergometer (60% of maximum heart rate) Upper & Lower limb strengthening with 50-60% of 1 Repetition maximum (RM)	1.Electromyo-graphy activity of the Sternoclei domastoid (SCM) muscle 2.Inspiratory muscle strength	IMT group- high MIP -Decreased in activity of sternocleid-omastoid muscle	Short-time training with low frequency In individuals with COPD, threshold IMT appears to be a useful technique for both enhancing inspiratory muscle strength and identifying SCM muscle activation on electromyography.

Author/ Year/ Country	Inclusion criteria	Intervention	Outcome measures	Result	Conclusion
Ana Lídia Carvalho Cutrim et. Al 2019/ Brazil [13]	- COPD with inspiratory muscle weakness or pulmonary hypertension without heart failure (PImax <70% of predicted)	POWERBreathe Medic + Plus IMT group- 12-weeks 30% of MIP – load 3 times a week, diaphragmatic breathing at a rate of 15-20 breaths per minute Control group- No load was set	1.Respiratory muscle strength 2.Spirometry 3. Heart rate variability (EMG) 4.6-minute walk test 5.Blood pressure (BP)	-No difference in spirometry -IMT group- improvement in MIP & MEP -No difference in BP -higher values in 6-Minute walk distance -total variability showed clinically significance indicating higher value in IMT group	In patients suffering from COPD, Cardiovascular autonomic modulation, expiratory and inspiratory capacity, and exercise tolerance were all enhanced after 12 weeks of IMT at 30% of maximal inspiratory pressure..
Daniel Langer et al. 2018/ Canada [14]	-Clinically stable COPD -MIP<70 cmH_2O -BDI < 9	POWERBreathe KH2 IMT Group- 8-weeks 2-3 sessions daily 30 breathes (4-5 minutes per session) Seven days a week for eight weeks 40% MIP at the beginning increased by much to 40–50% of MIP per week Control Group- Load <=10% of MIP	1.Modified Medical Research Council Dyspnea scale (mMRC) 2.BDI 3. Transitional Dyspnea index (TDI) 4.Spirometry5. Lung diffusing capacity 6.MIP and MEP 7.Respiratory muscle endurance 8.Exercise testing 10. EMG measurements ($P_{di,}$ Pga, P_{es})	IMT GROUP -Improvements in MIP and endurance -Decreased (Functional residual Capacity) FRC -Increased IC/ TLC (inspiratory capacity/ total lung capacity) -Decrease breathing frequency at rest -Improvement in MRC and TDI -EMGdi/EMGdimax – decreased - Training-induced variations to Pdi, Pes, and operational lung volumes during exercise	In moderate-to-severe COPD and a low baseline PImax, The percentage of inspiratory neural drive to the diaphragm, which is used for breathing during an intense physical activity, was reduced by supervised IMT.
Evgeniy S. Ovsyannikov et al. 2019/ Russia [15]	- FEV_1<50% of the predicted value - FEV_1/FVC<70% Group 1 is of obese people (BMI>30 kg/ m2). Group 2 is of normal individuals (BMI = 18.5-24.9 kg/m2)	POWERBreathe K5 breathing stimulator IMT training-8-weeks (in both groups) 1 minute warm up – 50% of expected full load 30 breaths- 3 times/ week for 8-weeks	1.Strength Index (SI) 2.Peak Inspiratory flow (PIF) 3.Average pressure of entire session 4.Average flow of entire session 5.Average power of entire session 6.Average volume of entire session 7.spirometry 8.mMRC	-Spirometry difference in FEV_1 & FVC showed in Group-1 -Decreased dyspnea is seen in Group-1 & lack of improvement in Group-2 -PIF and SI improvement seen in Group-1	The study's findings show that IMT benefits COPD patients, and that its benefits are higher in obese patients than in normal-weight patients.

Author/ Year/ Country	Inclusion criteria	Intervention	Outcome measures	Result	Conclusion
Jaya negi et al. 2019/ India [16]	40 to 80 years old - Patients with mild to moderate stable COPD; - Capable of doing inspiratory muscle training and incentive spirometry; - Medically stable as determined by the physician	Group A (Experimental Group) – 4-weeks (Threshold device - Philips) Inhale for one minute, twice a day for ten to fifteen minutes at a time (up to thirty minutes eventually). over a period of four weeks. Group B (Control Group) – Inhale hold and exhale through the incentive spirometer. 10-15 times/session. 2 times/day for 4 weeks	1.mMRC 2.BDI 3.TDI	-mMRC scale showed notable variations in both groups' pre- and post-treatment -BDI and TDI showed more significantly changes in Experimental group	When it comes to increasing inspiratory capacity and decreasing dyspnea—which may be brought on by an increase in the strength of the respiratory muscles—IMT is more successful than the incentive spirometer treatment program.
Renata P Basso-Vanelli et al. 2016/ Brazil [17]	- Both genders aged >50 years - Have not engaged in pulmonary rehabilitation within the last six months; - Are clinically stable with no history of infection, exacerbation, or respiratory symptoms for at least a month	POWERBreathe 4 months (3times/ week) IMT Group- 2-minute inspiration – 1 minute rest (7 times) 1st week – 10cmH_2O Weekly increased load – Up to 60% of MIP + Exercises - Stretching, Treadmill - 85% MHR -Flexors & extensors of LL – resisted exercise) Calisthenic and breathing Group (CAB) - Protocol of 9 exercises 1 exercise – 15 repetitions + Exercise (above mentioned)	1.Spirometry 2.MIP 3.Inspiratory muscle Endurance 4. Thoracoabdominal measurement (excursion) 5.6-Minute walk Test 6.Exercise treadmill test (modified Bruce protocol) 7.mMRC	MIP- IMT- increased 26 cmH_2O CAB - increased 10 cmH_2O Predicted MIP% IMT- increased 26% CAB- increased 10.6% Sustained MIP IMT-increased 19cmH_2O CAB-Increased 4cmH_2O Abdominal Mobility IMT-increased at axillary & abdominal CAB-Increased - 3 levels 6-Minute walk distance IMT-increased 46m CAB-Increased 34m Only IMT with respiratory muscle weakness shows greater increased in MIP and sustained MIP but no changes in CAB group	Both treatments reduced dyspnoea during physical exertion and enhanced exercise capacity. IMT performed better. IMT participants with respiratory muscle weakness showed larger gains in muscular endurance and inspiratory strength, but not in submaximal exercise capacity or dyspnoea.

Author/ Year/ Country	Inclusion criteria	Intervention	Outcome measures	Result	Conclusion
Sherin hassan mohammad mehani 2017/ Egypt [18]	-ATS- moderate degree of COPD -FEV_1<=50-70% of the predicted value -50-60-year-old -No respiratory infection in past 2 months -Not enrolled in any pulmonary rehabilitation programme -Smokers with an index of <400	Threshold device – Respironics IMT Group –2-months 5 deep breaths/ set (15% MIP that was increased every week by 5-10% up to 60% of MIP at 2 months) 6 sets – 3 times/ week for 2 months + Sham/placebo EMT with fixed load of 7 cmH_2O EMT Group – Same intensity as IMT group (Expiration) + Sham/placebo IMT with fixed load of 7cmH_2O	1.Pulmonary Functions- FVC, FEV_1, FEV_1/ FVC 2.Maximal Inspiratory Pressure 3.Maximal Expiratory Pressure 4.Arterial Blood Gas Analysis (ABG) 5.6-Minute Walk Distance	-Significant difference can be seen in pulmonary functions within the group -Maximal Inspiratory Pressure significantly increased in IMT & Maximal Expiratory pressure significantly increased in EMT - The IMT group experienced a large decrease in $PaCO_2$ (partial pressure of carbon dioxide) and an increase in PaO_2 (partial pressure of oxygen). Additionally, the IMT group saw a significant increase in HCO_3 and SaO_2% (oxygen saturation). -6MWD significantly increased in IMT group	For patients with mild airway blockage, a pulmonary rehabilitation program needs to involve both respiratory and expiratory muscle training, to increase blood oxygenation, respiratory muscle strength, pulmonary function test, and 6-min walking distance.
Wenhui Xu et al. 2018/ China [19]	- COPD that is clinically stable- Unaware of pulmonary rehabilitation - Willing to take part	Threshold device – Respironics 48min/day- 7days/ week for 8 weeks Sham IMT Group: 16 sets (training with no load) IMT Group: 8 IMT sets and 8 no-load training sets CTSC Group: sixteen sets of combined training in a one resspiratory cycle CTDC Group – 8 sets of IMT & 8 sets of EMT in different cycles	1.Respiratory muscle strength 2.Breathing pattern 3.Dyspnea scale 4.Spirometry 5.6-minute walk test 6.Quality of life 7.Nutritional status 8.BODE Index	-Significantly increased PI_{max} in all 3 groups except Sham IMT -Significantly increased PE_{max} in CTSC & CTDC group compare to IMT & Sham IMT -No changes in Breathing pattern, Spirometry parameters and 6-Minute walk test -significant difference in QOL and emotional status of all 3 groups except Sham IMT	In contrast to IMT alone, which only increased PImax, both the CTSC and CTDC patterns enhanced both expiratory and inspiratory muscular strength. Patients with COPD who have weak inspiratory muscles may benefit more from respiratory muscle training, which may alter the respiratory cycles.

DISCUSSION:

COPD causes serious systemic consequences, including muscle dysfunction, which mainly includes respiratory and peripheral muscle dysfunction. [20] Both local and systemic variables are important in the development of COPD. Respiratory muscle dysfunction is mostly caused by biomechanical imbalance and due to increased preloads and hyperinflation. Whereas reduced physical activity leads to the deconditioning of peripheral muscles, Other contributing factors to muscle dysfunction in COPD patients are Smoking, poor diet and gas exchange, exercise, exacerbations, systemic inflammation, and drugs. All factors mentioned above cause protein imbalance, injury, local inflammation, and oxidative stress by modifying the local microenvironment of the muscle. [21] So, the question arises: how do we know the severity of respiratory muscle dysfunction in COPD? Nam-Sik Kim et al. assessed the strength of respiratory muscle in Chronic Obstructive Pulmonary Disease patients, where they showed that maximum

inspiratory pressure (MIP) is more helpful to assess the strength of inspiratory muscle and also concluded that inspiratory muscles reflect the severity of COPD in a better way when compared to expiratory muscle strength. [22] Inspiratory muscle strength training (IMST) modifies various mechanisms and strengthens inspiratory muscles using different modes of devices such as resistive, pressure threshold, and normocapnic hyperpnea. [23] Out of all these IMT methods, one is training with a pressure threshold device. There are threshold IMT devices and POWERBreathe K series devices that are used to train the inspiratory muscles.

1. **Threshold IMT device:** This device permits resistance changes in increments of 2 cm H2O and allows for loads ranging from 9 to 41 cm H2O. It contains a one-way spring-loaded valve that closes upon inspiration; in order to open the valve, inhalation must be strong enough.. This device provides constant pressure regardless of how quickly or slowly the participants breathe, and the optimal loading pressure can be adjusted based on the individual characteristics of the participants. [24]
2. **POWERbreathe K-Series:** It is an inspiratory muscle trainer that uses an electronically controlled response valve to generate the resistance, which ranges from 10 to 240 cmH2O. The limitation of this device is its high cost, which makes this method the preserve of specialist clinics. [25]

Methodological qualities of the included studies: Out of these 30 studies, 21 consist of a randomised controlled trial or a randomised trial. Other 09 studies consist of prospective cohort, cross-sectional, longitudinal, and comparative pilot studies.

Outcome Measures: The majority of the studies (around 10) had a similar outcome measure to check the respiratory muscle strength, which is maximal inspiratory pressure. As proven by the studies, inspiratory muscle strength showed more evident respiratory muscle weakness in patients with COPD than expiratory muscle strength. The Modified Medical Research Council Dyspnea Scale and Baseline Dyspnea Index were the most common scales used in most studies to assess dyspnea. The most common outcome measure is a 6-minute walk test to assess the walking distance that was increased after the inspiratory muscle training.

Effects of Inspiratory Muscle Training: Gosselink et al. published a meta-analysis that concluded that IMT helps patients with COPD achieve increased respiratory muscle strength and endurance, which lowers dyspnoea and enhances their ability to engage in functional activity and their quality of life. Patients with more muscle weakness seem to be better responders, especially when considering IMT in addition to general exercise training. [26] In a systemic review and meta-analysis published in 2018, Youna Hong et al. discovered that telemonitoring can lower hospitalisation and ER visit rates while also improving mental health quality of life scores for COPD patients based on patient severity and type of intervention. It ought to incorporate the online teaching of coping mechanisms or instruction, such as pulmonary rehabilitation, which is suggested to result in a noticeable improvement of the patient's condition. This tele-monitoring method is a more useful application of information and communication technologies in patients with severe COPD than those with moderate severity. [27]

Effectiveness and the mechanism behind every parameter change:

1. Inspiratory muscle training (IMT) and respiratory muscle strength and endurance

The threshold device requires the participants to generate a preset pressure load to open a valve system that is present in the device, which therefore provides an effective stimulus for increasing maximal pressure-generating ability. [14]

Following IMT, there will be an increase in the size of type II muscle fibres and also an increase in the velocity of inspiratory muscle shortening, which allows more time for exhalation and relaxation that reduces dynamic hyperinflation and facilitates lung emptying and improvements in FEV_1, FEV_1%, FVC, and FVC%. [18] Threshold IMT shortens the inspiratory time, which will give the patient the patient more time to breathe and relax, which will promote lung air evacuation and an improvement in maximal inspiratory pressure.

Inspiratory muscle recruitment occurs in response to the extrinsic mechanical loading of IMT. Also, the static strength of the diaphragm is improved, with constant and large improvements seen in Pdisniff. IMT improved the ability to recruit more motor units during maximal voluntary activation of the diaphragm because of the combination of increased strength and potential neural adaptation that facilitated motor unit recruitment. [15]

Hence, these respiratory muscles have the same properties as the other skeletal muscles; the diaphragm and other respiratory muscles are subject

to the same practice-dependent neuroplasticity as other muscles. Diaphragm and other respiratory muscle coordination improve the MIP. [38] However, transdiaphragmatic pressure and neural respiratory drive are much greater through threshold inspiratory training in patients with COPD, which also has a greater effect on diaphragmatic mobilization. [10]

Mainly, the changes that are gained after inspiratory muscle training are after 8 weeks. Most of the published literature has a protocol duration of 8 weeks, and after that, only these changes can be seen as increased inspiratory muscle strength, endurance, exercise capacity, dyspnea reduction, improved quality of life, and health status. Therefore, the minimum requirement for the duration of muscle training to get the desired response is 8 weeks.

After 8 weeks of threshold training, there was an increase in MIP in COPD patients by 14.7%25, 22.7%, [39] 26% [18], 36% [3], 42% [12], and increased respiratory endurance to 532 seconds. [29]

There were not many changes found in any of the outcome measures (inspiratory muscle strength, 6-minute walk test, pulmonary function test, inspiratory capacity at rest, and at the end of 6-MWT) that followed 3-week duration training, and that is because the period of training was too short and intensity was also too low to gain the improvements. [30]

2. IMT and 6-minute walk distance and exercise capacity

Reduction in respiratory muscle fatigue, perception of dyspnea, and increased blood flow to the working muscles via attenuation of respiratory muscles were reported, so all these components will enable subjects to perform greater walking distance in 6-MWT. Improvement in exercise capacity was accompanied by improvement in ventilation and increased oxygen uptake, along with enhanced diaphragmatic force, which ultimately decreased the sensation of dyspnea in submaximal exercise. [31]

IMT decreases the metaboreflex, allowing more blood flow to the peripheral muscles that are exercising. [32]

IMT reduces fatigue of the lower limb exertion; if there is overload of the inspiratory muscle, there is a reflex response to peripheral vasoconstriction directing blood flow to the respiratory muscles, causing fatigue of the lower limb. So as a result, there will be an increase in the 6-minute walk distance through inspiratory muscle training. [18]

After inspiratory muscle training for 2 months (8 weeks) in elderly patients with COPD, there will be a 25% increment in walking distance. [19]. Patients with inspiratory muscle weakness in COPD have increased walking distance by more than 45 metres. [3,32]

3. IMT and Dyspnoea

There is a change in the feedback of sensory and proprioceptive receptors in the rib cage, which reduces the efferent commands of the efferent commands of the central neurons for a given level of ventilation, providing desensitisation to dyspnea. [24] Improvement in MIP and inspiratory endurance could lower the oxygen cost of voluntary hyperpnea and relieve the perception of dyspnea. [10]

After 8 weeks of training with the threshold loading device, reduced activation of the SCM was detected, and that might be due to an improvement in synergy of the inspiratory muscles that led to a reduced activation load of the muscles that are extremely required by patients with COPD. So IMT provided a reduction in the EMG activity of SCM in patients with COPD. [12]

4. IMT and quality of life (QoL)

Patients's daily living activities are now not that restricted by dyspnea after this training. So, feelings of anxiety and depression subsided, giving rise to feeling well-being and also improving health status. [33] High-intensity inspiratory training has an effect on all five domains of the SF-36 questionnaire. Mainly, the psychological and physical domains are improved. [3] Increased inspiratory muscle strength led to a decrease in dyspnea perception and, hence, improved QoL by reducing problems in routine life.

Inspiratory muscle training vs. different devices and training:

1. IMT vs. Expiratory Muscle Training (EMT)

IMT and EMT for 2 months revealed that IMT improved MIP (14.7%), P_aO_2, HCO_3, SaO2, and 6-MWD (25%), while EMT improved MEP only. IMT is superior to EMT because the recruitment of strong expiratory muscles alone is not enough to eliminate dyspnea associated with effort. Whereas, IMT didn't improve the expiratory muscle strength.[19] Despite lung hyperinflation, during expiration, abdominal muscle recruitment preserves fibre length and the force-generating ability of the diaphragm for the onset of inhalation, and therefore, inspiratory muscles may get fatigued if expiratory muscle dysfunction occurs. [20] Therefore, it is essential to implement

both inspiratory and expiratory muscle training in patients with COPD in their pulmonary rehabilitation programme in order to achieve greater improvement in respiratory muscle strength, blood oxygenation, 6-MWT distance, and pulmonary function tests. [19]

2. IMT: Threshold versus Power Breath

4-week training with the threshold and POWERBreathe devices increased MVV, MIP, and MEP in both groups and increased PEFR in the POWERBreathe group only. Here, the threshold device has a limited load of up to 41 cmH_2O, whereas the POWERBreathe device used in this study has a load up to 78 cmH_2O. Additionally, when participants reached 70–80% of their MIP (45.5–52 cmH_2O), researchers were forced to train those participants with 41 cmH_2O as the limit of the threshold device. But threshold devices have superiority in improving the strength of inspiratory muscle. [34]

3. IMT vs. Resistive Training

8 weeks of resistive training with the PFLEX device (RIMT) and threshold IMT device (TIMT) led to meaningful improvements in muscle strength: 22.2% in the RIMT group and 22.7% in the TIMT group; an increase in peak work rate of 21.6% in the RIMT and 1.1% in the TIMT group; an increase in peak VO2max of 14.8% in the RIMT and 10.1% in the TIMT group; HRQoL also changed in both groups; and an increase in exercise duration in both the group.[35] After 8 weeks of training with tapered flow resistive loading (TFRL) and mechanical threshold loading (MTL), significant changes were seen in inspiratory muscle strength: 18 cmH_2O (25%) in the MTL and 31 cmH_2O (45%) in the in the TFRL group, and an increase in breathing endurance of 532 seconds in the TFRL group and 187 seconds in the MTL group. [29] The improvement with the TFRL device is due to its ability to objectively measure the unsupervised training, and it can apply different loads. Lastly, it was concluded that this TFRL group achieved higher intensities and improvements than mechanical threshold loading training. [29]

4. Inspiratory Muscle Training (IMT) vs. Incentive Spirometer (IS)

IMT using a pressure threshold device is for strength training, which mainly works on the muscle strength, and an incentive spirometer is for improvement in lung volume and capacity, which mainly works on the airways, like in and out of the air flow movement from the lungs. After 4 weeks, when comparing the incentive spirometer and inspiratory muscle training in COPD patients, improvements in the MRC scale, BDI, and TDI were more significantly seen in the IMT group. [17] After 4 weeks of training in patients with COPD with IS and IMT, improvement was seen in MIP, RR, TV, and the and the Dyspnea Numerical Rating Scale. [35] The delay in fatigue of IMT is superior to that of IS, but IS improves the intraalveolar pressure, which is proportional to respiratory contractile force (46), and respiratory muscle function, so these positive clinical outcomes are sufficient to encourage its use. [35]

IMT is an important device that could be easily used by patients with COPD. Though there are so many pros and cons to the devices, with a better understanding and an appropriate prescription, it can help the patient overcome such difficulties in their day-to-day lives.

CONCLUSION:

This literature review suggests that 8 weeks of well-structured, tailored inspiratory muscle training (IMT) using a pressure threshold device in pulmonary rehabilitation is very effective in patients with chronic obstructive pulmonary disease (COPD).

By using a pressure threshold device, there is a significant improvement in inspiratory muscle strength and inspiratory muscle endurance. This increased muscle strength leads to reduced early fatigue. With the training, there is reduced work of breathing as a reduction in accessory muscle activation, and it also reduces hyperinflation, and by that, there is a reduction in the perception of dyspnea.

As dyspnea is reduced, there is increased exercise capacity, an improved 6-minute walking distance, and an improvement in QoL. There is decreased anxiety and depression that can also be seen after the training.

This literature review is to explain the benefits of the threshold device and the dosage of the treatment plan. Hence, this study concluded that the IMT gives an additional benefit to the patients with COPD, helping them to be physically and psychosocially independent, and that is why the use of inspiratory muscle training in patients with COPD using the pressure threshold device is recommended in clinical practice in pulmonary rehabilitation in an Indian setting.

CONFLICT OF INTEREST: None
SOURCE(S) OF SUPPORT: None

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