

## Effectiveness of Cough Assist Device in Exercise Capacity in COPD Patients

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### Abstract

Coughing is the body's defense mechanism to clear the airways from the foreign bodies and secretions. In patients with neuromuscular disorders or other diseases affecting the airways such as cystic fibrosis (CF), the effectiveness of this defense mechanism is often reduced due to respiratory exhaustion. Some COPD patients have also difficulty in airway clearance. The aim of this study was to evaluate the effectiveness of cough assist device in COPD patients. In this study, we randomized 20 COPD patients admitted to the pulmonary ward of Masih Daneshvari Hospital (Tehran, Iran) into two groups of routine physiotherapy (including active cycle of breathing technique, pursed-lips breathing, diaphragmatic/abdominal breathing, huffing, and coughing) and routine physiotherapy plus 10 sessions of cough assist, each for 20 minutes. Cough assist pressure was set +5 to +30 cmH<sub>2</sub>O for inspiration and -8 to -33 for expiration, for 1-3 and 3-5 seconds, respectively. The two groups were then compared regarding the results of 6-minute walk test (distance) and spirometry parameters. The mean age of the patients was  $61 \pm 4$  years. The results of the analysis demonstrated that there was a significant difference between the two groups.

**Keywords:** cough assist; respiratory physiotherapy; COPD

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### Introduction

Coughing is the body's defense mechanism to clear the airways from the foreign bodies, dust, and airway secretions [1, 2]. This mechanism is particularly important in patients with pulmonary disease who experience muscle weakness due to increased respiratory workload or central nervous system disorders interfering with normal respiration [3, 1]. Further, effective coughing is the first-line defense against foreign pathogens. In its absence, the chances of lower respiratory tract infections significantly increase. The effectiveness of coughing is compromised in patients with neuromuscular disorders, bronchiectasis, and CF. Further, there is difficulty in airway clearance in some COPD patients causing diminished exercise capacity and lung volume.

Aside from medications, a wide range of physiotherapeutic as well as rehabilitative techniques and devices are used today to aid in clearance of airway secretions. Cough is triggered by an input from

two distinct receptors: mechanical receptors commonly located in the upper airways such as larynx, trachea, and carina, plus chemical receptors, which are found in bronchi and lower airways [2]. In each cough reflex, afferent impulse from stimulation of receptors is mainly relayed through the vagus nerve to the cough center in medulla and pons, which communicate with higher neural centers in the brain and cortex. This communication allows for voluntary initiation and control of the cough. In addition, each cough cycle consists of three phases: 1) deep inspiration to provide enough air for initiation of cough; 2) increasing air pressure within the lungs by closure of glottis and contraction of intercostal and abdominal muscles plus diaphragm; and 3) rapid expiration of air by abrupt opening of the larynx [2].

Ineffective cough can be considered as a major underlying cause of treatment failure and even death in pulmonary patients. In patients with neuromuscular disorders or COPD patients, the inability of respiratory muscles to sustain an effective cough cycle results in retention of secretions and phlegm in the airways. These

**Table 1.** Demographic parameters of subjects

Sex		N	Mean	Std. Deviation
Male	Age	20	61	4.26875
	Hight	20	149	16.77260
	Weight	20	66	14.73117
	Bmi	18	19	4.15413

patients, therefore, require the use of mechanical cough assist devices to clear their airways. This device enhances the force of expiration to help clear the airways.

Application of the device usually involves 3-5 cycles during expiration with or without intra-abdominal pressure, followed by 30 seconds of rest [5]. This cycle is repeated until secretions are successfully cleared.

## Materials and Methods

In this study, COPD patients admitted to Masih Daneshvari pulmonary department (Tehran, Iran), who had resting oxygen saturation (SpO<sub>2</sub>) above 88% and were considered for respiratory physiotherapy by their physician, were evaluated to enter the study. Informed consent was obtained from the patients or their legal guardians. The patients were randomized into one of the two study groups using block randomization: control group receiving conventional physiotherapy (respiratory exercises, chest massage, percussion), and study group receiving physiotherapy as well as cough assist, using Pegaso A-cough device (Dima Italia Srl, Bologna, Italy).

Cough assist was used for a total of 10 sessions of 20 minutes for each patient. Device adjustments were made daily for each patient. A range of +5 to +30 was used for inspiration and -8 to -33 for expiration. Inspiratory time was set between 1 and 3 seconds, while expiratory time for 3 to 5 seconds.

The inclusion criteria for the study were definite diagnosis of COPD by a 40-70 years, and having a resting SpO<sub>2</sub> above 88%. The exclusion criteria were defined as inability, noncompliance, or unwillingness to participate, and deterioration of symptoms.

The two study groups were compared regarding the spirometry findings and 6-minute walk test (6MWT) results. Data for each patient were collected in predefined forms covering demographic characteristics such as age and level of education and laboratory measurements.

Statistical analysis was performed using SPSS v.19 software (SPSS Inc., Chicago, USA). Normal distribution of the data was assessed using Kolmogorov-Smirnov test. Descriptive statistics were presented as mean±standard deviation where appropriate. *P* value <0.05 was considered statistically significant.

**Table 2.** Comparison of parameters in two groups

	Group	Mean	Sig.
Fev1	Study	46	.001
	Control	31	.001
Fvc	Study	44	.001
	Control	36	
Fev1/Fvc	Study	84	.001
	Control	80	
Distance	Study	411	.001
	Control	399	

## Results

Overall, 20 patients with a mean age of 61±4 years were selected for the study. The study group consisted of 10 patients, who were compared with 10 patients in the control group. Demographic

The results of 6-minute walk test (distance) and spirometry are shown in Table 2.

The results of the analysis revealed that the mean scores for spirometry parameters are 37 (fev1), 41 (fvc), and 85 (fev1/fvc) in the study group in comparison with 40, 41, and 84 respectively in the control group after the treatment. As seen in Table 2, any spirometry indices were significant in the two groups. The distance in 6MWT is 406 meters in the study group in comparison with 411m in the control group, which were signification between the two groups.

## Discussion

Cough assist devices are used as a complementary assistance to conventional physiotherapy. An effective cough consists of three phases: deep inspiration, glottis closure, and sudden expiration [6]. Difficulty at any of these phases results in an ineffective cough mechanism, increasing the chance of pulmonary infections. This is the most common reason for hospitalization of patients with neuromuscular disorders [7]. The main goal of respiratory physiotherapy, therefore, is to clear the airways especially in patients with COPD and other conditions that increase respiratory secretions. Since the 1970s, different methods have been proposed for COPD patients to facilitate expulsion of sputum and mucus from the airways [7]. These encompass a wide range of techniques including active cycle of breathing technique, autogenic drainage technique, mucolytic techniques, local drainage, and thoracic massage and vibration, and devices including PEP device, vibration during PEP use, intra-airway percussion, and cough assist devices [8]. In two short-term reports by Thomas *et al.* [9] and Van der Schans *et al.* [10], their use in CF patients has been effective.

However, there are no long-term studies evaluating the effectiveness of these physiotherapeutic techniques and devices.

In a study by Chatwin *et al.*, use of MI-E resulted in improvement of peak cough flow, as a measure of effective cough, in patients with neuromuscular disorders [11, 12], but not in chronic obstructive pulmonary disease or emphysema patients [1], which is in line with our findings. Further, a study by Boitano *et al.* evaluating the effect of physiotherapy and rehabilitative programs in patients with neuromuscular disorders demonstrated improved quality of life and increased life expectancy in these patients [13]. For CF patients, on the other hand, MI-E devices can be considered as a useful option for clearance of secretions, although their use is limited by their high costs and poor portability, rendering them only a suitable option for long-term treatment [14]. These findings are in accordance with our results. Another study confirmed the important role of cough in ICU patients, especially in those with muscle weakness [15]. Another similar study by Bach *et al.* indicated the effectiveness of MI-E devices in conjunction with conventional physiotherapy techniques in patients with neuromuscular disorders and pulmonary infection [16]. Finally, a study by Fauroux Brigitte on 17 clinically-stable children with Duchenne muscular dystrophy, spinal muscular atrophy, or congenital myopathy showed that the use of two inspiration-three expiration cycles using 15, 30, and 40 cmH<sub>2</sub>O in each cycle had a significant effect on the physiology of respiration in these patients [17].

## Conclusion

In conclusion, we observed that physiotherapy in conjunction with cough assist use for 10 sessions could enhance the pulmonary function parameters in COPD patients. Patients in the study group experienced a significant change in spirometry parameters, in comparison with the control group.

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### Authors' contributions:

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