

COMPARATIVE EFFECTS OF ACTIVE CYCLE OF BREATHING TECHNIQUE AND HIGH FREQUENCY CHEST WALL OSCILLATIONS IN CHRONIC OBSTRUCTIVE PULMONARY DISEASE PATIENTS

Nosheen Irum¹, Sidra Afzal², Madiha Ali³, Ayesha Iqbal⁴, Shagufta Mureed⁵, Muhammad Faisal Javed⁶

Riphah college of rehabilitation, riphah international university, Lahore, Pakistan

ABSTRACT

Chronic Obstructive pulmonary diseases can be defined as irregularities in the small airways of the lungs characterized by constant and progressive lung airflow obstruction. Its symptoms progressively compromise the patient ability to function normally COPD management comprises a multidisciplinary approach. Physiotherapy management of COPD includes sputum removal techniques where copious secretions lead to discomfort.

Objective: To compare the effects of active cycle of breathing technique and high frequency chest wall oscillations in chronic obstructive pulmonary disease patients.

Methods: Study plan was randomized clinical trial. The study was conducted at pulmonary department of DHQ hospital NAROWAL. The study was completed six months after the approval of synopsis. Sample size is 42. Consecutive sampling technique was used. Patients were allocated into two groups A and B. group A was treated with active cycle of breathing pattern and group B treated with high frequency chest oscillations. Post treatment readings were taken at the end of 4th week. Total treatment sessions were twelve and four weeks of training and three sessions per week. The data analysis was done by using SPSS version 25

Results: 42 subjects were screened according to inclusion and exclusion criteria. Procedure was explained to them and informed consent was taken. Patients were randomly allocated into two groups. Group A received active cycle of breathing technique with routine chest physiotherapy. Group B received high frequency chest wall oscillations. Normality of test was checked by Shapiro wilk test that showed that data was normally distributed with p value > 0.05. A paired sample t test and independent samples t-test was conducted to compare the effects of Active cycle of breathing technique and High frequency chest wall oscillations method in in between and within group

Conclusion: ACBT and HFCWO shows major improvement in treating COPD, but when associated both the techniques patients which are treated with high frequency oscillation have shown better effects as compared to other technique.

Index terms-Chronic obstructive pulmonary disease, active cycle of breathing techniques, high frequency chest wall oscillation, lung airflow obstruction,

multidisciplinary approach, physical therapy management, routine chest physiotherapy.

I INTRODUCTION

Chronic Obstructive pulmonary diseases can be defined as irregularities in the small airways of the lungs characterized by constant and progressive lung airflow obstruction. Complaints of chronic obstructive pulmonary disease are trouble in breathing, cough, and abundant sputum production⁽¹⁾. The continuation of COPD is affiliated with expanding frequency and intensity of exacerbations. The obstructed airway leads toward decreased lung function, diminish quality of life, and a greater risk of hospitalization and lower respiratory tract infections⁽²⁾. COPD management comprises a multidisciplinary approach. Physiotherapy management of COPD includes sputum removal techniques where copious secretions lead to discomfort⁽³⁾.

Positive expiratory pressure devices, oscillatory positive-expiratory pressure device and high-frequency chest wall oscillation (HFCWO), intermittent positive pressure breathing (IPPB) are the techniques that are used from many years for secretion management⁽⁴⁾.

ACBT is more effective than most approached therapies on removal in chronic obstructive pulmonary disease⁽⁵⁾.

Devices of chest physiotherapy (CPT) have come out as a replacement to conventional chest physiotherapy. Oscillatory devices direct to break down the enzymes in the sputum and vibrate the secretions of the chest. The selection of the suitable device for each patient is a challenge as a means to gain better compliance⁽⁶⁾. The use of devices has less evidence as compared with other techniques. Wall for the removal of secretions⁽⁷⁾. Chest physical therapy guide to several techniques to better lung volumes⁽⁸⁾. Active Cycle of Breathing technique and clearance of shortness of breath are performed in tripod position⁽⁹⁾. Airway clearance techniques aims to remove secretions in patients with chronic productive cough, mucus production on chest-CT and air way clearance techniques are aimed to change the viscoelastic properties of secretions⁽¹⁰⁾. Chronic bronchitis is one of the common COPD disorder characterized by the presence of air flow obstruction that is mostly progressive, may be go with hyperactivity and may be partially reversible⁽¹¹⁾.

High frequency chest wall oscillation generate compression of the chest wall and improve secretion management in COPD ⁽¹²⁾.

An oscillating device generates extra- or intra-thoracic HFCWO for airway clearance .High-frequency chest wall oscillations produce extra-thoracic oscillations ⁽¹³⁾. Active cycle of breathing techniques (ACBT) is a conventional technique, and it carries some benefits. Active cycle of breathing technique includes individual own cooperation, and requires no use of any particular device ⁽¹⁴⁾. Cystic fibrosis patients found HFCWO therapy as effective as for COPD ⁽¹⁵⁾. Tobacco smoke is the most common cause of COPD .It is evaluated that 20% of people who have COPD have never smoked. .COPD is diagnosed via spirometer ⁽¹⁶⁾. MD SHAN and colleagues in 2021 conduct colleague held a study on high frequency chest wall oscillations and active breathing technique in COPD patients. Patients were randomized into three groups. Intervention group received the ACBT with phonophoresis .Initial results were changes in mucus thickness and lung functions, pulse oximeter. Secondary results include COPD assessment and anxiety ⁽¹⁷⁾.

DV Theresa and colleague conducted a study in 2021 to observe the effectiveness of .After 4 weeks of intervention expiration with open glottis seem to be more helpful than active cycle of breathing active cycle of breathing technique and slow expiration with opened glottis in subjects with bronchiectasis.60 subjects with age group 45-75hing te ⁽¹⁸⁾.

T Singh and colleagues in 2019 conducted a study on efficacy of active cycle of breathing technique against autogenic drainage in patients observed with bronchitis.30 subjects were randomly assigned into two groups. The active cycle of breathing technique with postural drainage and autogenic drainage effective individually ⁽¹¹⁾.

High-frequency chest wall oscillation (HFCWO) is an airway clearance technique that creates high velocity, low amplitude oscillatory airflows via a pneumatic vest worn over the thorax, and is used for increasing airway mucus clearance in different disease ⁽²⁰⁾. According to the Global Initiative for Chronic Obstructive Lung Disease (GOLD), the Chronic Obstructive Pulmonary Disease (COPD) defined as a preventable and treatable condition, with significant effects that may result in different levels of functional deterioration .COPD is known as one of the main reason of death throughout the world ⁽²¹⁾.

Active cycle of breathing technique (ACBT) is one of the methods in pulmonary rehabilitation adapted for asthmatic patients. ACBT leads towards clearance of airways in pulmonary patients. The ACBT and forced expiratory technique are applied for airway clearance with chronic lung disease. The enormous production

of secretion in asthmatic patients leads to airway obstruction and sputum retention ⁽²²⁾.

Active cycle of breathing technique (ACBT) used to accelerate the enormous secretion from the distal part of the lung. .. Each cycle of ACBT have the following 3 steps: Control breath that can decrease airway narrowing and increase oxygen saturation, thoracic expansion exercises that mobile secretion and improve alveolar ventilation, and forced expiratory technique (FET) ⁽²³⁾.

The goals of physiotherapy are to optimize oxygen transport, improve ventilation-perfusion matching, increase lung volumes, reduce work of breathing, and enhance mucosal clearance. Most ICU studies have investigated the short-term effects of multimodality physiotherapy on pulmonary function in intubated patients receiving mechanical ventilation⁽⁶⁾ .

The aim of this study is to determine whether high frequency chest wall oscillation or active cycle of breathing technique is more effective for improving sputum viscosity expectorations and lung functions in COPD patients .This study provide evidence which of the technique helps to perform the ADLS by improving the quality of life.

II METHADODOLOGY

A randomized clinical trial was conducted at DHQ Hospital NAROWAL. The study was accomplished in six months after the approval of synopsis. A Sample size 42 was calculated by online EPITOOL sample size calculator by putting following values of SPADI score from previous study: Sample size to detect a significant difference between two means. The Consecutive sampling technique was used to collect samples. The patient was selected for the study according to following inclusion and exclusion criteria. The inclusion criteria was Patient with clear consciousness, stable vital sign, and ability to cooperate, Stage 3-4 COPD regarding to GOLD criteria, Adult patients

And Patient who had given informed consent were included in the study. The exclusion criteria was Active lung tuberculosis, Chest wall trauma, Thoracic or abdominal operations in last three months and Presence of cardiac pacemaker, artificial stunt or heart failure.

Active cycle of breathing technique consists of breathing control thoracic expansion and forced expiration technique. The patient was asked to relax the upper body, use the lower chest, normal 3-4 tidal volume breaths were taken. In Thoracic expansion, patients were randomly allocated into two group.

GROUP A:

Group A received active cycle of breathing technique with routine chest physiotherapy. .Patient in Group A receiving active cycle of breathing technique were performed in semi fowler position and given command

to perform three steps of active cycle of breathing technique. The patient was given instructions to breathe deeply and percussion was performed on chest by therapist. In each session 3-4 thoracic expansion exercise was given. Three sessions of treatment per week were given. Post treatment readings were taken at the end of 4th week. Total treatment sessions were 12. Total treatment was of 4 week (19).

GROUP B:

Group B received high frequency chest wall oscillations. Group B received high frequency chest wall oscillations through vest system. Patients were instructed to sit in relaxed and comfortable position. Three sessions in a week of 20-30 minutes were given. Inflatable vest was applied to individual chest wall and at the end of session deep breathing was recommended. The patients were under observation during the whole session (20).

Following MCPT the physiotherapist gave the patient positional recommendations for continuing ACBT and gave them a summary on a sheet of paper. Throughout the remainder of their hospital stay, the patient was instructed to continue collecting any further expectorant that came up. According on perceived clinical need, the physiotherapist decided on the substance, frequency, and length of additional MCP treatments while the patient was hospitalized. For patients in the control arm, the physiotherapist gave instructions on the components of ACBT, advice on acceptable positions to help with sputum clearance (21). The efficacy of high-frequency chest wall oscillation application was assessed with the "BODE index". The BODE index will be calculated using the body mass index (B), forced expiratory volume in the first second (O), modified Medical Research Council dyspnea scale (D) and 6-minute walking test (E) Parameters of the BODE index included:

Body mass index (BMI): calculated according to the kg/m² formula. performed with the MIR Spiro lab II spirometer in the sitting position. Best forced expiratory volume in the first second values among three consecutive measurements will be recorded according to the European Respiratory Society/American Thoracic Society pulmonary function tests standardization criteria.

Dyspnea: The modified Medical Research Council dyspnea scale was used.

Exercise capacity: a 6-minute walking test was performed. The patients were motivated to walk at the maximum speed in the 35-m corridor and the walking distances were recorded in meters at the end of six minutes (22) After taking consent from the patient, inclusion and exclusion criteria were taken into account Potential participants will be considered. They were requested to participate in the study.

1. Randomization.

2. The patients complete BODE Index assessment was done as subjective measurement.

3. Treatment was continued to the selected subject according to their allocation.

In next visits:

1. Patients was reassessed by the accessor (third person)

2. Three sessions of treatment per week was given. Post treatment readings was taken at the end of 4th week. Total treatment sessions were 12. Total treatment was of 4 weeks. Data was analyzed on SPSS 25.

III RESULTS

Thirty-eight subjects were screened according to inclusion and exclusion criteria. Procedure was explained to them and informed consent was taken. Patients were randomly allocated into two group. Group A received active cycle of breathing technique with routine chest physiotherapy. Group B received high frequency chest wall oscillations. Normality of test was checked by Shapiro wilk test that showed that data was normally distributed with p value > 0.05. Parametric test was used to compare two populations at different variance intervals. A paired sample t test and independent sample t test was conducted to compare the effects of active cycle of breathing and high frequency chest wall oscillation in between and within a group. Patient that were included in the study with the mean age of 34.25 ± 0.68 for ACBT patients and 32.43 ± 0.61 for HFCWO patients and body mass index was 26.16 ± 0.76 for ACBT patients and 24.03 ± 0.50 for HFCWO patients. Total score of BODE INDEX with its all four parameters i.e. FEV1, 6-min walk test, Dyspnea and BMI, p values in between 2 groups ACBT and HFCWO method after 4 weeks of intervention are 0.026, 0.004, 0.006, 0.001 respectively. P value within groups pre and post intervention is significant for both groups

There was a significant Mean difference in the BODE scores for ACBT (2.32) and HFCWO (2.41) after treatment. P value is significant for both group but there was greater difference with HFCWO than ACBT group. So, these results suggest that high frequency chest wall oscillation method has greater effects on curing chronic obstructive pulmonary disease than the active cycle of breathing techniques after the treatment sessions. Results also stated that there was a significant Mean difference in the DYSPNEA scores for ACBT (2.32) and HFCWO (2.41) after treatment. P value is significant for both group but there was greater difference with High frequency chest wall oscillation than active cycle of breathing technique group. So, these results also suggest that HFCWO has greater effects on curing chronic obstructive

pulmonary disease than the ACBT after the treatment sessions.

Table 1: Mean standard deviation in post assessment groups

Variable	ACBT (n = 19)	HF (n = 19)	P-value
	Mean ± SD	Mean ± SD	
FEV1% pred.	53.89 ± 9.30	67.79 ± 12.73	0.00
6MWD (m)	346.47 ± 45.01	409.47 ± 108.25	0.025
MMRC	2.84 ± 0.50	2.63 ± 0.60	0.247
BMI	26.97 ± 4.94	26.63 ± 7.26	0.124

Table 1 shows baseline values including mean ± SD and P value of both groups ACBT and HFCWO method.

Table 2: Paired Sample t-test BODE score at pre-assessment and post assessment within and in between group

Variable	ACBT (n = 19)	HF (n = 19)	Mean difference	P-value
	Mean ± SD			
Pre-assessment	107.54 ± 14.83	126.62 ± 32.21	19.08	0.00
Post-assessment	109.86 ± 14.52	129.03 ± 32.03	19.17	0.00
Mean difference	2.32	2.41		
P-value	0.048	0.05		

ACBT = Active Cycle of Breathing Techniques

HFCWO = High frequency chest wall oscillation

A paired sample t test and an independent samples t-test was conducted to compare the effects of ACBT and HFCWO method in in between and within group. There was a significant Mean difference in the BODE scores for ACBT (2.32) and HFCWO method (2.41) after treatment. P value is significant for both group but there was greater difference with HFCWO method than ACBT group. So, these results suggest that HFCWO method has greater effects on curing coronary obstructive pulmonary disease than ACBT after the treatment sessions.

Table 3: Paired sample t-test in pre and post assessment of participants. BODE INDEX mean in pre-assessment and post assessment of participants

Variable	Baseline		Post intervention		P-value	
	ACBT (n = 19)	HF (n = 19)	ACBT (n = 19)	HF (n = 19)	Between 2 groups	Within group
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD		
FEV1% pred	54.72 ± 0.90	56.30 ± 0.62	53.42 ± 0.72	58.34 ± 0.77	0.026	0.004
6MWD (m)	186.33 ± 10.26	222 ± 6.56	215.33 ± 9.07	266 ± 6.24	0.004	0.00
MMRC	2.57 ± 0.31	2.64 ± 0.29	3.76 ± 0.79	3.97 ± 0.74	0.006	0.03
BMI (kg/m ²)	26.96 ± 0.42	25.8 ± 0.27	24.11 ± 0.37	23.10 ± 0.34	0.001	0.040

Table shows that A paired sample t test and an independent samples t-test was conducted to compare the effects of ACBT and HFCWO method in in between and within group. Total score of BODE including all of its 4 parameters i.e. FEV1, 6MWD, MMRC, BMI. P values in between 2 groups ACBT and HFCWO method after 4 weeks of intervention are 0.026, 0.004, 0.006, and 0.001 respectively. P value within groups pre and post intervention is significant for both groups.

Table 4: Dyspnea score at pre-assessment and post assessment within and in between group

Variable	ACBT (n = 19)	HF (n = 19)	Mean difference	P-value
	Mean ± SD	Mean ± SD		
Pre-assessment	2.05 ± 0.78	2.16 ± 0.37	19.08	0.222
Post-assessment	1.94 ± 0.71	2.32 ± 0.48	19.17	0.331
Mean difference	2.32	2.41		
P-value	0.222	0.331		

Table 4 shows that A paired sample t test and an independent samples t-test was conducted to compare the effects of ACBT and HFCWO method in between and within group. There was a significant Mean difference in the DYSPNEA scores for ACBT (2.32) and HFCWO method (2.41) after treatment. P value is non-significant for both group but there was greater difference with HFCWO method than ACBT group. So, these results suggest that HFCWO method has greater effects on curing coronary obstructive pulmonary disease than ACBT after the treatment sessions.

IV-DISCUSSION

The study's primary objective was to contrast the effects of active cycle breathing techniques with high frequency oscillations in patients with chronic obstructive pulmonary disease. The findings of the present investigation demonstrated that, upon completion of all therapy sessions, high frequency oscillation had superior effects on COPD patients compared to ACBT. Both groups of patients saw a decline in the severity of their conditions, but the patients who used the high frequency oscillation therapy improved more. Similar to how other research from earlier literature revealed high frequency oscillation had superior impact on patients with chronic obstructive pulmonary disease. The use of chest physical therapy in the management of COPD is crucial. HFCWO procedures aim to percuss the entire lung removing secretions and maybe clearing the bronchial tree.

In a research on the effectiveness of a vest-mounted high-frequency chest wall oscillations device against a flutter device in acute exacerbations of chronic obstructive pulmonary disease, Taghreed S. Farad and colleagues published their findings in 2018. Three groups of

108 individuals with acute exacerbations of chronic lung illness were created. Patients with acute pulmonary illness exacerbations respond well to both high frequency chest wall oscillations and the flutter device.⁽⁶⁾

In our study high frequency chest wall oscillations effects were observed with ACBT technique for better airway clearance and improved lung capacity.

Although methods for enhancing the normal mucus and cough clearance mechanisms of the lungs are not new, in recent years a number of methods have been created that are efficient and comfortable. The majority of teenagers and adults may employ these methods without the assistance of a caregiver. One of the methods that has received the most research in recent years is HFCWO, which has been applied in a variety of situations including thoracic trauma, Neuromuscular illnesses, chronic obstructive pulmonary disease, bronchial asthma and cystic

fibrosis.⁽²¹⁾ HFCWO proved to be very effective in various pulmonary conditions.

In our study we observed the effects of high frequency chest wall oscillations in COPD with other technique in order to improve lung functions. The cellularity of sputum and its alterations during airways clearance therapy were not examined in any of the earlier research. All patients participating in the two groups (HFCWO and CPT) presented at the beginning with a total cell count suggesting in each patient the absence of infection if we take into consideration already established definitions employed in the examination of sputum cellularity. The proportion of neutrophils decreasing and the proportion of macrophages increasing may indicate a modification of HFCWO in inflammatory cells (higher than CPT), but further research is required to confirm these findings. High frequency chest wall oscillations showed impact on inflammatory cells. In our study high frequency chest wall oscillations impact on acute exacerbation of COPD were observed.

The effect of HFCWO has been shown to improve MCC in CF children, adults with bronchiectasis and neuromuscular illness, and in COPD patients. However its usage in COPD is new. The purpose of this pilot trial was to examine the feasibility of employing this technique to improve MCC in patients with intermediate to severe COPD, where greater sputum production and retention can cause more exacerbations, hospital admissions, and a faster loss in lung function.²⁵ In addition to evaluating the effects on sputum, another goal was to evaluate the acceptability and tolerability of this kind of treatment in older patients with debilitating COPD symptoms and frequently many comorbidities.⁽²³⁾

In our study we observed further effects of high frequency chest wall oscillations with other

In a Canadian study, the authors observed that after using a flutter device for 1 week, the exercise tolerance and 2-hour post bronchodilator spirometer of 15 severe COPD patients improved.⁹ Therefore, even though this was not significantly established in this pilot trial, it is possible that effective MCC in COPD patients may have an effect on the rate of decrease in lung function in the future.

A randomized trial involving bronchiectasis patients looked at the effectiveness of ACBT and PD on factors linked to pulmonary function. The findings showed that ACBT was substantially more effective than PD at improving FVC, FEV1, and PEFr. As a result, it was shown that ACBT had a higher positive effect than PD in opening up the airways and enhancing pulmonary function in bronchiectasis patients.¹⁹ Again, in bronchiectasis patients, there was a significant improvement in FVC after ACBT, FEV1 after CPT, and dyspnea after ACBT and CPT. Both

treatment techniques can be used in clinical settings for patients with bronchiectasis, it was determined. 17 Another prospective RCT looked at how five different ACTs, including ACBT.⁽²⁵⁾ACBT in bronchiectasis showed better effects in enhancing pulmonary function and airway clearance. In our study ACBT was compared with high frequency chest wall oscillations for better airway clearance and enhanced pulmonary functions.

V-CONCLUSION

ACBT and high frequency chest wall oscillations shows remarkably improvement for the management of COPD. However high frequency chest wall oscillations have more effects in improving acute exacerbation of COPD.

Conflict of Interest: There was no conflict of interest.

Financial statement: No funding's were given by any authorities; it was a project thesis of doctor of physical therapy.

REFERENCES:

1. Quissesa A, Juhdeliena J, Gultom ECV. HIGH-FREQUENCY CHEST WALL OSCILLATION: AIRWAY CLEARANCE MANAGEMENT FOR OBSTRUCTIVE PULMONARY DISEASE PATIENTS. *Nursing Current: Jurnal Keperawatan*. 2021;9(2):116-27.
2. Jaiswal KK, Das AK. Effectiveness of Acapella, Flutter and Active Cycle of Breathing Technique on Lung Function in COPD Patients: A Comparative Study. *Executive Editor*. 2019;13(1):71.
3. Shamakh M, Badr N, El-Batanouny M, Shendy M. Acapella versus hand-held positive expiratory pressure on Pulmonary functions in management of chronic obstructive pulmonary diseases. *Journal of Advanced Pharmacy Education & Research* Apr–Jun. 2020;10(2).
4. Nicolini A, Grecchi B, Ferrari-Bravo M, Barlascini C. Safety and effectiveness of the high-frequency chest wall oscillation vs intrapulmonary percussive ventilation in patients with severe COPD. *International journal of chronic obstructive pulmonary disease* 2018;13:617.
5. Shen M, Li Y, Ding X, Xu L, Li F, Lin H. Effect of active cycle of breathing techniques in patients with chronic obstructive pulmonary disease: a systematic review of intervention. *European Journal of Physical and Rehabilitation Medicine*. 2020;56(5):625-32.
6. Farag TS, Mariam E. Utility of vest high frequency chest wall oscillation device versus flutter device in acute exacerbation of chronic obstructive pulmonary disease. *Int J Res Med Sci*. 2018;6(1):1-9.
7. Daynes E, Greening N, Siddiqui S, Singh S. A randomised controlled trial to investigate the use of high-frequency airway oscillations as training to improve dyspnoea in COPD. *ERJ Open Research*. 2019;5(3).
8. Zisi D, Chryssanthopoulos C, Nanas S, Philippou A. The effectiveness of the active cycle of breathing technique in patients with chronic respiratory diseases: A systematic review. *Heart & Lung*. 2022;53:89-98.
9. Zuriati Z, Surya M. Effectiveness Active Cycle of Breathing Technique (ACBT) with Pursed Lips Breathing Technique (PLBT) to tripod position in increase oxygen saturation in patients with COPD, West Sumatera. *Enfermeria Clinica*. 2020;30:164-7.
10. Theresa DV, Jyothi S, Apparao P, Swamy CG. EFFECTIVENESS OF ACTIVE CYCLE OF BREATHING TECHNIQUE AND SLOW EXPIRATION WITH GLOTTIS OPENED IN LATERAL POSTURE [ELTGOL] ON QUALITY OF LIFE AND FUNCTIONAL CAPACITY IN SUBJECTS WITH BRONCHIECTASIS.
11. Singh T, Kumar N, Sharma N, Patra A. Effectiveness of Active Cycle of Breathing Technique along with Postural Drainage Versus Autogenic Drainage in Patients with Chronic Bronchitis. *Physiotherapy and Occupational Therapy*. 2019;12(1).
12. Westerdahl E, Osadnik C, Emtner M. Airway clearance techniques for patients with acute exacerbations of chronic obstructive pulmonary disease: Physical therapy practice in Sweden. *Chronic respiratory disease*. 2019;16:1479973119855868.
13. Osman LP, Roughton M, Hodson ME, Pryor JA. Short-term comparative study of high frequency chest wall oscillation and European airway clearance techniques in patients with cystic fibrosis. *Thorax*. 2010;65(3):196-200.
14. Mohamed AM, Badr NM, Hagag AA, Mohamed YM. Intra versus extra-thoracic oscillations in chronic obstructive pulmonary disease (a randomized clinical trial). *J Adv Pharm Educ Res*. 2019;9.
15. Üzmezoğlu B, Altıay G, Özdemir L, Tuna H, Süt N. The efficacy of flutter® and active cycle of breathing techniques in patients with bronchiectasis: a prospective, randomized, comparative study. *Turkish thoracic journal*. 2018;19(3):103.

17. Barto TL, Maselli DJ, Daignault S, Stiglich J, Porter J, Kraemer C, et al. Real-life experience with high-frequency chest wall oscillation vest therapy in adults with non-cystic fibrosis bronchiectasis. *Therapeutic advances in respiratory disease*. 2020;14:1753466620932508.
18. Ntritsos G, Franek J, Belbasis L, Christou MA, Markozannes G, Altman P, et al.
19. Gender-specific estimates of COPD prevalence: a systematic review and meta-analysis. *International journal of chronic obstructive pulmonary disease*. 2018;13:1507.
20. Lin Y, Tung H, Wang T. Comparative study of high frequency chest wall oscillation and traditional chest physical therapy in intensive care unit patients. *J Comp Nurs Res Care* 2017;2:115.
21. Nicolini A, Cardini F, Landucci N, Lanata S, Ferrari-Bravo M, Barlascini C. Effectiveness of treatment with high-frequency chest wall oscillation in patients with bronchiectasis. *BMC Pulmonary medicine*. 2013;13(1):1-8.
22. Goktalay T, Akdemir SE, Alpaydin AO, Coskun AS, Celik P, Yorgancioglu A. Does high-frequency chest wall oscillation therapy have any impact on the infective exacerbations of chronic obstructive pulmonary disease? A randomized controlled single-blind study *Clinical rehabilitation*. 2013;27(8):710-8.
23. Al Kazaleh A. Effects of Deep Breathing Exercise on Patient with Chronic Obstructive Pulmonary Disease. *EC Pulmonology and Respiratory Medicine*. 2020;9:114-7.
- Trashchenko E. Case study of a patient with pneumonia after COVID-19 disease. 2021.
24. Goktalay T, Akdemir SE, Alpaydin AO, Coskun AS, Celik P, Yorgancioglu A. Does high-frequency chest wall oscillation therapy have any impact on the infective exacerbations of chronic obstructive pulmonary disease? A randomized controlled single-blind study. *Clinical rehabilitation*. 2013;27(8):710-8.
25. Nicolini A, Cardini F, Landucci N, Lanata S, Ferrari-Bravo M, Barlascini C. Effectiveness of treatment with high-frequency chest wall oscillation in patients with bronchiectasis. *BMC Pulmonary medicine*. 2013;13(1):1-8.