https://doi.org/10.48047/AFJBS.6.Si4.2024.537-547

African Journal of Biological Sciences

Autogenic drainage versus active cycle of breathing techniques on respiratory functions and arterial blood gases following upper abdominal surgeries

Abdelaziz Ali Abdelaziz[1],Wafaa Hussein Borhan[2], Ramadan Mahmoud Ali[3], Mohmed Maher Elkeblawy[4], Eman Mohamed Othman[2]

1. Department of Physical Therapy, Chest Hospital, Zagazig, Sharkia, Egypt,
2. Department of physical therapy of surgery, Faculty of physical therapy, Cairo University, Giza, Egypt.
3. Department of surgery, Faculty of Medicine, Zagazig University, Zagazig, Egypt.
4. National center of research, Giza, Egypt.

Corresponding author: Abdelaziz Ali Abdelaziz
Email: Drabdelazizali2006@gmail.com

Article History

Volume 6, Issue Si4, 2024
Received: 25 May 2024
Accepted: 15 June 2024
doi:
10.48047/AFJBS.6.Si4.2024.537-547

Abstract

Background: Like other large abdominal procedures, upper abdominal surgeries can weaken respiratory muscles in the postoperative phase and cause mechanical alterations in the lungs. Patients may experience significant decreases in respiratory function following these procedures, depending on the presence of previous conditions.

Purpose: This study was conducted to assess the impact of the active cycle of breathing techniques versus autogenic drainage for improving the pulmonary functions and arterial blood gases of upper abdominal surgery patients.

Subjects and methods: Sixty patients (38 males and 22 females) underwent upper abdominal surgeries (abdominal exploration)and aged from 40-55 years were selected at random from Al-Ahrar learning hospital one day post-operative and divided into two equal groups in number, each group involved 30 patients. Patients in **group (A)**was given active cycle of breathing techniques in addition to early ambulation while patients in **group (B)**was given autogenic drainage in addition to early ambulation intervention. Patients in both groups were examinedat baseline and following 7 days of treatment (post-training) to measure forced expiratory volume in 1 second (FEV1) using pulmonary function test (PFT) and PCo2 using ABG lab testing.

Results: The results of this study showed that there was significant increase in both forced expiratory volume in 1 second (FEV1) with P-value = 0.11 and significant decrease in PaCo2 with P-value = 0.11 for both groups of the study.No significant difference was observed amongactive cycle of breathing techniques and autogenic drainage.

Conclusion: Both techniques had the same effect in improving pulmonary functions and arterial blood gases in post upper abdominal surgeries patients.

Key Words: (Active cycle of breathing techniques, Arterial blood gases, Autogenic drainage, Respiratory functions, Upper abdominal surgeries)

INTRODUCTION

The diaphragmatic function of the breathing muscles is primarily affected by the upper abdominal procedures. A surgical incision may produce direct trauma in certain cases, but reflex inhibition of the phrenic nerve following viscera manipulation in the majority of cases results in altered breathing patterns that increase the risk of respiratory problems [1]

Both general anesthesia and surgical procedures have direct effects on the respiratory system. Lung volumes, including total lung capacity (TLC), vital capacity (VC), and tidal volume (TV), are impaired after upper abdominal surgery, which affects postoperative pulmonary functioning. It will make coughing less effective up to a week after taking it. Both the oxygen arterial pressure as well as the saturation of hemoglobin drop. Based on the criteria used to define them, postoperative pulmonary problems might affect anywhere from 6% to 70% of patients following upper abdomen procedures. Some examples of these conditions are atelectasis, pneumonia, and hypoxemia [2]

The normal clearance of respiratory secretions occurs via coughing, cephalad airflow bias, as well as mucociliary transfer. An elevated risk of infection results from decreased secretion clearance brought on by higher secretion volume and viscosity, dyskinesia of the cilia, as well as a weak cough in disease. An additional complication of obstructive lung disease is the initial collapse of airways caused by compression, that traps gas and secretions [3]

Methods have been devised to enhance airway clearance and maximize expiratory flow. Compared to placebo and on par with postural drainage in terms of therapeutic effects, directed cough, forced expiratory method, active cycle of breathing, as well as autogenic drainage all perform just as well as each other without the need for specialized equipment or the support of a care provider. According to research, the active cycle of breathing as well as forced expiratory method, when combined with normal chest physical treatment, are more successful than chest physical therapy alone. Despite the fact that methods like autogenic drainage may necessitate more control and training for successful implementation, evidence-based reviews recommend teaching patients with chronic secretion management issues as many of these techniques as they can learn to incorporate into their treatment plans [3]

There is a lack of knowledge about the impact of AD and ACBT on the pulmonary complications following upper abdominal surgeries.

This study was done to compare the impact of ACBT and AD that are used separately on patients of upper abdominal surgeries and their impact on arterial blood gases and pulmonary functions of these patients.

SUBJECTS AND METHODS

- **Design and sample**

A comparative study was done on 60 patients in physical therapy department for surgery, Alahrar teaching hospital, Zagazig, Sharkia, Egypt, from where the patients were also recruited from January 2023 to October 2023. Each participant in the study had the protocol thoroughly explained to them before any procedures were performed.

Participants' ages ranged from 40 to 55, and their body mass index (BMI) was measured between 26 and 29 after they had upper abdominal surgery. Patients were also eligible to participate in the trial provided they fulfilled the following criteria: a surgical duration of 120 minutes or longer; an abdominal incision that is five cm or more above the navel; and a predicted length of hospital stay following surgery of six days or greater. The exclusion criteria included: Patients who suffer

from any uncontrolled condition (pulmonary diseases, hypertension and cardiovascular instability), Patients with severe fungal disease, acute viral diseases and hemorrhage as well as those who couldn't follow physiotherapy instructions.

Patients were randomized into one of two groups by a nurse who was blinded of the study's design and who opened sealed envelopes containing randomized cards generated by a computer group (A) received active cycle of breathing techniques in addition to early ambulation while patients in group (B) received autogenic drainage in addition to early ambulation intervention.

- **Outcome measures**

The outcome measurements were changes to pulmonary function value forced expiratory volume in 1 second (FEV1) and changes to arterial blood gases (ABG) partial pressure of carbon dioxide PaCo2.A pulmonary function test was done with patient in sitting position, the therapist explained the process to the patient, adjusted the device and started the testing program. The patient was asked to place the mouthpiece in his/ her mouth. The patient sealed his lips around the mouthpiece as tightly as possible, the patient was asked to breath in all his/ her air in as much as possible for 6 seconds and hold for 2 seconds then to blow out as much as possible in the device for 6 seconds. The therapist instructed the patient to hold for at least 2 second. The best result was taken for 3 successful tests. ABG testing was done by a professional nurse,an arterial blood sample was taken from the patient and sent to the lab. The results were documented in the patient sheet. These were measured on the $1^{st}$and 7^{th} day postoperatively for both groups of the study.

- **Intervention:**

Every single day, the treatment program was given twice, once in the morning and once in the afternoon.

- **Autogenic Drainage Group:**

Chevaillier [5] of Belgium created autogenic drainage. Aiming for maximum airflow in the various bronchial generations to transfer secretions, this method avoids the use of forced expiration [4].

"Unstick," "collect," and "evacuate" were the three stages of AD that Schoni [16] outlined. In the first stage, the patient's functional tidal volume was inhaled within the range of their closure volume, beginning beneath the level of functional residual capacity. It was called low lung volume breathing. The patient was told to exhale as much air as they could and then inhale and exhale at the same effective tidal volume that they had learned before [4].

The frequency of vibration of secretions on the periphery of the airways is high, but it decreases as they migrate towards the center. The individual was instructed to transition from the (ERV) to the IRV in order to address this feedback. This involved breathing through low, intermediate, as well as high lung volume levels. This was referred to as the "collect" phase [4]

To improve secretion transport efficiency, functional tidal breathing was advanced to intermediate and high lung volume levels; as lung volume increased, flow velocity increased and secretion transport became more efficiently in these airway levels [4]

The last stage of airway clearance involves aspirating secretions out of the trachea or central airways and into the mouth. One possible method for this is to use a controlled cough or huff[5]

- **Active Cycle of Breathing Techniques Group:**

ACBT included five to six sessionsof breathing exercises, chest expansion exercises included three to four sessions, and two to three forced expiratory procedures. All elements of the ACBT cycle must be included and mixed with breathing control; however, the number and frequency of each element can be changed. A booklet outlining the steps for administering ACBT was distributed to the patients[6]

Prior to any action, patients were asked to sit or lie down and relax their shoulders. The respiratory control procedure consisted of three deep, slow breaths in through the nose, followed by a three-second hold, and finally, three to five repetitions of moderate-to low-degree lip contracting breathing out to achieve an inspiration-expiration ratio of 1:2-3. This was done in succession to clear the airways of any respiratory secretions. As part of the chest expansion training, participants would hold their breath for three seconds after actively deepening their inhalation, during which they would feel their chests expand. After this, they would passively relax, breath out 3 or 4 times, and contract their chest wall muscles to vibrate their secretions. When secretion enters the central airway, the forced expiratory technique is conducted as follows: take a long breath in, aggressively and forcibly pull the abdomen back, open the glottis simultaneously, and exhale with 362 or 3 low breaths (forced sighs). Breathe out deeply two or three times, and then repeat the process. This should be repeated two or three times consecutively, followed by quiet breathing. As a final step in encouraging lung expansion, patients were instructed to cough up any remaining deep sputum after the preceding procedures. The recommended amount of time for each training cycle was 10-15 minutes, and patients were advised to do four sessions of ACBT every day [7]

RESULTS

To compare the subject characteristics between the groups, an independent t-test was used. To compare the gender distribution between the groups, a chi-squared test was used. The Shapiro-Wilk test was used to ensure that the data followed a normal distribution. The homogeneity of variances among groups was tested using Levene's test. Statistical analysis was carried out using the statistical package for social studies (SPSS) version 25 for windows (IBM SPSS, Chicago, IL, USA). The purpose of the study was to compare the effects of time (pre versus post) and treatment (among groups), in addition to the interaction among the two, on FEV1, PaCO2.

- ***Subject characteristics*:**

Group A and B's characteristics are displayed in Table (1). When comparing the groups according to age, weight, height, BMI, and gender distribution, no significant difference was found ($p > 0.05$).

Table 1. Comparison of subject characteristics between group A and B:

	Group A	**Group B**	**p-value**
	Mean ± SD	**Mean ± SD**	
Age (years)	48.97 ± 4.69	49.90 ± 3.10	0.36
Weight (kg)	80.37 ± 4.48	78.96 ± 5.39	0.27
Height (cm)	171.37 ± 3.40	169.87 ± 4.63	0.16
BMI (kg/m²)	27.39 ± 1.76	27.38 ± 1.75	0.98
Sex			
Females	10 (33%)	12 (40%)	0.59
Males	20 (67%)	18 (60%)	

SD, standard deviation; p value, probability value

- **Impact of treatment on FEV1 and PaCO2:**

The results of the mixed MANOVA showed that the variables treatment and time interacted significantly (F = 3.77, p = 0.009). The main effect of time was statistically significant (F = 756.34, p < 0.001). F = 0.78, p = 0.54 indicates that the therapy had no significant main effect.

- Within group comparison:

Both Group A and Group B had statistically significant improvements in FEV1 and PaCO2 after treatment compared to before (p > 0.001). Both FEV1 and PaCO2 changed by 52.27 and 17.04% in group A, compared to 55.91 and 20.65% in group B, respectively. (Table 2 and 3)

- Between groups comparison:

Before treatment, there was no statistically significant difference among the groups (p > 0.05). Groups A and B did not differ significantly in terms of FEV1 and PaCO2 after treatment (p > 0.05). (Table 2 and 3).

Table 2. Mean FEV1 pre and post treatment of group A and B:

	Group A	**Group B**		
	Mean ± SD	**Mean ± SD**	**MD**	**p value**
FEV1 (L)				
Pre treatment	0.88 ± 0.23	0.93 ± 0.28	-0.05	0.42
Post treatment	1.34 ± 0.23	1.45 ± 0.26	-0.11	0.11
MD	-0.46	-0.52		
% of change	52.27	55.91		
	p = 0.001	***p = 0.001***		

SD, standard deviation; MD, mean difference; p-value, probability value

Table 3. Mean PaCO2 pre and post treatment of group A and B:

Partial pressure (mmHg)	**Group A**	**Group B**		
	Mean ± SD	**Mean ± SD**	**MD**	**p value**
PaCO2				
Pre treatment	41.90 ± 2.42	42.62 ± 1.87	-0.72	0.20
Post treatment	34.76 ± 2.49	33.82 ± 1.96	0.94	0.11
MD	7.14	8.8		
% of change	17.04	20.65		
	p = 0.001	***p = 0.001***		

SD, standard deviation; MD, mean difference; p-value, probability value

DISCUSSION:

This study was designed to compare effectiveness of ACBT and AD on pulmonary function and arterial blood gases after upper abdominal surgeries.

Complications such as aspiration, infections, respiratory failure, as well as sepsis occur in 30% to 64% of patients who have upper abdominal operations [8]

In addition, some individuals experience a decrease in lung function right after surgery. As with any surgery involving the upper abdomen, there will be certain changes following the operation, including a decrease in lung volume, a rise in respiratory rate, malfunction of the respiratory muscle, difficulty controlling breathing and oxygenation, and an elevation in pulmonary secretion. It has been shown that the diaphragm muscle moves less after upper abdominal surgery [9]

In the postoperative (PO) periods, respiratory muscle strength may be impaired after upper abdominal procedures, as it is with other large abdominal surgeries, which cause mechanical alterations in the lungs. Severe reductions in respiratory function in obese patients following such procedures are possible, although this is conditional on the presence of underlying diseases [10]

Reports indicate that the diaphragm muscle has decreased mobility following upper abdominal surgery. The surgical procedure affected the abdominal wall's compliance, which raised intra-abdominal pressure and inhibited the muscle's function through reflex processes, leading to this decrease [11]

Hence the present study was done to assess improvement of the postoperative complications as to the use of ACBT and AD. This study was conducted on sixty patients underwent upper abdominal surgeries,aged from 40 to 55 years and were distributed into two equivalent groups (30 patients each), matched for measured variable. Group B received AD and traditional chest physical therapy, performed 2 times per day for 7 days. Group A receivedACBT and traditional chest physical therapy, performed 2 time per day for 7 days.

The findings of this study showed a significant improvement in FEV1 after 7 days of training sessions (post treatment) in both groups of the study in a favor of (Group B) with percentage of improvement (55.91%.). Statistical significance was established at the conventional P value < 0.05.

In addition, statistical analysis revealed a significant decrease PaCO2 of both groups after 7 days of training sessions (post treatment) in both groups of the study in favor of (Group B) with percentage of improvement (17.04%) of PaCO2.Statistical significance was established at the conventional P value < 0.05.

This improvement in pulmonary functions for (Group A) and (Group B) may be due to improvement of diaphragm mechanics, power, inspiratory muscle strength and more sufficient secretion clearance.[12,13]

ADadd to the successful treatment of postoperative upper abdominal surgeries as well as thoracic trauma patients. The use of AD was reported in the literature as to its following advantages:

Chevaillier[5] used these findings as the basis for his description of AD as a set of principles. According to his consideration, which is based on research by Alexander[14] and subsequently by Kraemer et. al.[15], a three-stage breathing exercise was used to achieve the maximum achievable airflow in successive generations of bronchi by controlled breathing [16]

Their study's findings suggest that routine chest physiotherapy following UAS, when combined with the AD method, improves blood gas levels, reduces hospital stays, and prevents pulmonary problems. On top of that, patients report few side effects [17]

Patient fatigue as well as dyspnea were decreased in patients with cystic fibrosis (CF) when all respiratory physiotherapy techniques based on AD were applied. Spirometric parameters along with blood oxygen saturation were also improved [18]

One breathing method frequently employed in the treatment of CF is AD. Secretions can be removed by modifying the volume of breathing to generate shearing forces [19]

ACBTadd to the successful treatment of postoperative upper abdominal surgeries as well as thoracic trauma patients. The use of ACBT was reported in the literature as to its following advantages:

Most British CF centers have taught this kind of home management for air way clearance since the beginning of the 1980s. This approach is now known as ACBT [20].

Patients suffering from chronic lung disease that is marked by excessive secretions often undergo airway clearance procedures such as the ACBT as well as the Forced Expiratory Technique (FET)[21].

As the mucus is drawn into the central airways, it can be more easily released by this combination, which might be seen as having a "milking" activity. There has been no research on the efficacy of physically compressing the chest wall when exhaling as a means to maximize expiratory effort using the huff cough [3].

ACBT can be easily altered to teach to a wide spectrum of patients. Every patient can have their cycle customized. Various cycles have been detailed, each with the ability to alleviate a unique set of symptoms [3].

The FET has the potential to be the most effective method for clearing airways if properly taught [22]

The findings of this study were in agreement with previous studies and the post literature by **SavciSet. al. 2012**[23]They found that ACBT and AD were equally useful in clearing the airway of mucus, a common symptom of chronic obstructive pulmonary disease (COPD). This was demonstrated by the fact that lung function tests improved.

However, Charpot et al. 2021[24] stated that the results from AD and ACBT are statistically non-significant. Additionally, active cycle of breathing and autogenic drainage were found to be highly beneficial when used independently.

Findings from this study corroborated those of Buragadda et al. 2012 [25], who demonstrated that ACBT and AD are both useful in clearing secretions—a source of obstruction of the airway in COPD patients.

Wilson (2023) [26] said that ACBT was about the same as other treatments when it came to outcomes like quality of life, individual preference, exercise tolerance, pulmonary function, sputum weight, oxygen saturation, as well as the number of recurrence The capacity to demonstrate the superiority of one method over another was lacking.

Consistent with the present investigation, Samuel et al. 2019 [27] found that ACBT and AD significantly improved dyspnea as well as mucus clearance in chronic bronchitis (CB). In terms of dyspnea and mucus clearance, however, AD had the same effect as ACBT. When it comes to CB, the choice between the two therapies for airway clearance is up to the patient along with therapist.

Research conducted by Moiz et. al. in 2007 [28] found that in patients experiencing an acute exacerbation of COPD, AD was just as effective as ACBT in clearing secretions and enhancing oxygen saturation. Furthermore, it had no negative effects on heart rate, respiratory rate, or dyspnea.

Miller et al. [7] compared AD with ACBT, postural drainage, and percussion, and they discovered better ventilation (as evaluated by nuclear medicine scans), which was in contradiction with the findings of the present study. Autogenic drainage led to a higher airway clearance rate compared to ACBT.

Finally it can be concluded that there is no significant difference between ACBT and AD on pulmonary function nor on arterial blood gases for postoperative upper abdominal surgery patients after using them for 7 days post-operative. Both techniques significantly improves the pulmonary functions, arterial blood gases, airway clearance in addition to improvement of mechanics of breathing. Although ACBT was easier to comprehend and patients (especially non-educated) found it easier to perfect its stages, patients in the AD group reported less tension in wound site, more secretion clearance and was less prone to airway collapse. Hence, ACBT and AD may be recommended for patients with upper abdominal surgeries to improve pulmonary functions and air way clearance which in turn reduce the severity of postoperative pulmonary complications. The selection of the technique should be decided by the therapist for each case with considering the patient preferences.

The limitations to this study werelack of control group, absence of further follow up, only 1 value was taken from PFT test and 1 value was taken from ABG test.This study's findings suggest that the following recommendations should be considered:

It was recommended to add ACBT and AD with different approaches and protocol to routine of physical therapy management post upper abdominal surgeries.

More researches were recommended to study the impact of ACBT and ADon dyspnea, exercise performance and quality of life in patients underwent upper abdominal surgeries.

Further studies were needed to differentiate between the effect of ACBT and ADin the rehabilitation program after upper abdominal surgeries.

More extensive studies should be conducted to ensure the efficacy of ACBT and ADin different ages.

Further researches were recommended to study the effect of pre- operative ACBT and ADon post operative complications.

Additional studies with larger patient populations would allow for more accurate statistical analysis.

Follow up sessions after 1-2 months of ACBT and ADtraining after upper abdominal surgeries should be conducted.

Additional studies could include a comparison among other physio- theraputical modalities.

Similar study should be conducted on abdominal wall and respiratory areas with other general surgeries.

CONCLUSION:

The most important conclusions, taking into account the study's limitations and the data collected, were:-

Active cycle of breathing techniques was an effective modality approach and had a significant improvement on pulmonary function and arterial blood gases for post upper abdominal surgeries patients as evidence by increase in forced expiratory volume for 1 second and decrease of PaCo2.

Autogenic drainage was an effective modality approach and had a significant improvement on pulmonary function and arterial blood gases for post upper abdominal surgeries patients as evidence by increase in forced expiratory volume for 1 second and decrease of PaCo2.

This study demonstrated that ACBT and ADare equally effective treatments in management of post upper abdominal surgeries pulmonary complications.

ACKNOWLEDGEMENTS
The authors appreciate the time and energy of the administrative staff and the volunteers in this study.

Disclosure statement
There is no financial conflict of interest or personal gain for any author associated with this study.

Conflict of interest
The authors have revealed no potential bias.

REFERENCES

1. **Arruda KA, Cataneo DC, Cataneo AJ (2013):** surgical risk tests related to cardiopulmonary postoperative complications. Comparison between upper abdominal and thoracic surgery.ActaCirúrgicaBrasileira; 28(6)
2. **Robert L C (2007):** High-Frequency Assisted Airway Clearance Respiratory care; 52:(9)
3. **James BF (2007):** "Forced Expiratory Technique, Directed Cough, and Autogenic Drainage". RESPIRATORY CARE • SEPTEMBER VOL 52 NO 9
4. **Paula Agostini, Nicola Knowles (2007):** Autogenic drainage: the technique, physiological basis and evidence, Physiotherapy, Volume 93, Issue 2, Pages 157-163
5. **Chevaillier J. (2016):** Autogenic Drainage: The Flow and Breathing Level Modulation Concept; Servei de Publicacions de la UniversitatAutònoma de Barcelona: Barcelona, Spain; Volume 9.
6. **Mcllwaine PM, Wong LTK, Pirie GE, Davidson AGF (1992):** Long term comparative trial of conventional percussion and drainage versus autogenic drainage in cystic fibrosis. XIth International CF Congress Book of Abstracts, Dublin:Allied Health Professionals No. 32 (abstract).
7. **S Miller, D 0 Hall, C B Clayton, R Nelson (1995):** Chest physiotherapy in cystic fibrosis: a comparative study of autogenic drainage and the active cycle of breathing techniques with postural drainage. Thorax ;50:165-169
8. **Ferguson MK and Durkin AE. (2002):** Preoperative prediction of the risk of pulmonary complications after esophagectomy for cancer, J ThoracCardiovasc Surg.; 123(4):661-9.
9. **Barbalho MM, Miguel G, Forti E and Costa D (2011):** Effects of preoperative inspiratory muscle training in obese women undergoing open bariatric surgery: respiratory muscle strength, lung volumes and diaphragmatic excursion. Clinics (Sao Paulo) ; 66(10): 1721–1727.
10. **Guimarães MM, El Dib R, Smith AF and Matos D (2009)**: Incentive spirometry for prevention of postoperative pulmonary complications in upper abdominal surgery. Cochrane Database Syst Rev.; (3):CD006058.
11. **Koenig SM (2001):** Pulmonary complications of obesity. Am J Med Sci.; 321:249–79.
12. **Kiwon S, Warren JW, Yong WL, Jongwon L and James EH (2005):** Investigation of non-uniform airflow signal oscillation during high frequency chest compression . Biomedical engineering on line; 4:35.
13. **Casandra AA, Cassandra AP, Arthur LN, Brian B, Steven DS and Robert RQ (2008):** Evaluation of the safety of high-frequency chest wall oscillation (HFCWO) therapy in blunt thoracic trauma patients. Journal of trauma management & outcomes; 2:8**.**

14. **Alexander FA. (1976):**PhysikalischeTherapiebeimkindlichen Asthma bronchiale. MschrKinderheilk;124:222-4
15. **Kraemer R, Zumbuihl C, Rudeberg A, Lentze, MJ, Chevaillier J. (1986):**'Autogene Drainage' beiPatientenmitzystischer Fibrose. PddiatrPrax;33:223-32
16. **M H Schoni (1989):**Autogenic drainage: a modern approach to physiotherapy in cystic fibrosis Journal of the Royal Society of Medicine Supplement No. 16 Volume 82
17. **Taha MM, Draz RS, Gamal MM, Ibrahim ZM.(2021):** Adding autogenic drainage to chest physiotherapy after upper abdominal surgery: effect on blood gases and pulmonary complications prevention. Randomized controlled trial. Sao Paulo Med J. Nov 15;139(6):556-563. doi: 10.1590/1516-3180.2021.0048.0904221. PMID: 34787294; PMCID: PMC9634842.
18. **Żak M, Gauchez H, Boberski M, Stangret A, Kempinska-Podhorodecka A. (2023):** Effectiveness of Autogenic Drainage in Improving Pulmonary Function in Patients with Cystic Fibrosis. Int J Environ Res Public Health. Feb 21;20(5):3822. doi: 10.3390/ijerph20053822. PMID: 36900829; PMCID: PMC10001450.
19. **Helper N, Kodesh E, Sokol G, Hakimi R, Vilozni D, Efrati O. (2020):** The benefits of mechanical insufflator-exsufflator compared to autogenic drainage in adults with cystic fibrosis. PediatrPulmonol. 2020 Nov;55(11):3046-3052. doi: 10.1002/ppul.25020. Epub Aug 24. PMID: 32776649.
20. **Lee A, Burge A and Holland A (2017):**"Positive expiratory pressure therapy versus other airway clearance techniques for bronchiectasis". *Cochrane Database Of Systematic Reviews*(9). https://doi.org/10.1002/14651858.cd011699.pub2
21. **Lucy K, Lewis A, Marie T, Williams A and Timothy SO (2012):** "The active cycle of breathing technique: A systematic review and meta-analysis". Respiratory Medicine 106, 155e172
22. **Van der Schans CP. (1997)**Forced expiratory manoeuvres to increase transport of bronchial mucous: a mechanistic approach. *Monaldi Archives of Chest Disease* 52:367-370.
23. **Savci S, Ince DI, Arikan H. (2000):** A comparison of autogenic drainage and the active cycle of breathing techniques in patients with chronic obstructive pulmonary diseases. J CardiopulmRehabil. Jan-Feb;20(1):37-43. doi: 10.1097/00008483-200001000-00006. PMID: 10680096.
24. **Vinal Charpot, Anjali bhise, Neela Soni (2021):**Comparision of Active Cycle of Breathing Technique and Autogenic Drainage Technique in Patient Who Had Under Gone Laparotomy Indian Journal of Physiotherapy and Occupational Therapy, July-September, Vol. 15, No. 3
25. **Buragadda, Syamala, Deepesh Sharma, Mohammed Abdulrahman Alghamdi and S. Arabia. (2012):** "Comparison of Autogenic Drainage & Active Cycle Breathing Techniques on FEV , FVC & PEFR in Chronic Obstructive Pulmonary Disease."
26. **Wilson LM, Saldanha IJ, Robinson KA. (2023):** Active cycle of breathing technique for cystic fibrosis. Cochrane Database of Systematic Reviews, Issue 2. Art. No.: CD007862. DOI: 10.1002/14651858.CD007862.pub5
27. **Samuel, Jincy. (2019):** "Immediate effect of the autogenic drainage over the active cycle of breathing technique in airway clearance in subjects with chronic bronchitis- a quasi experimental study." journal of clinical and diagnostic research, 2019,https://doi.org/10.7860/jcdr/42284.13263.

28. **Moiz, Jamal & Kishore, Kamal & Belsare, D.R.. (2007).** A comparison of autogenic drainage and the active cycle of breathing techniques in patients with acute exacerbation of chronic obstructive pulmonary disease. Indian Journal of Physiotherapy and Occupational Therapy.