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Effect of Acapella Versus Active Cycle of Breathing Techniques to Improve Airwayclearance and Exercise Capacity in Subjects with Bronchiectasis

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Abstract: Bronchiectasis is a chronic condition characterized by persistent cough and sputum production due to permanent thickening and dilation of the bronchial walls, resulting in impaired mucus clearance. This study aimed to compare the effectiveness of two physiotherapy techniques, Acapella device training and Active Cycle of Breathing Techniques (ACBT), in improving pulmonary function and exercise capacity. A quasi-experimental study was conducted with 64 participants with a mean age of 45 years, all clinically diagnosed with bronchiectasis. The participants were randomly assigned to two groups of 32 each. One group received Acapella device training, and the other group received ACBT. Both interventions were administered three times per week for six weeks. Outcome measures included pulmonary function tests and the six-minute walk distance. The results showed significant improvements within both groups, while between-group comparisons revealed that the Acapella group achieved greater improvements in both parameters. These findings indicate that although both techniques are effective, the Acapella device provides superior benefits in enhancing airway clearance and exercise capacity in individuals with bronchiectasis.

Keywords: Bronchiectasis, airway clearance, exercise capacity, 6min-walk distance, pulmonary function tests, active cycle of breathing techniques, acapella device

1. Introduction:

Bronchiectasis is a chronic respiratory disease characterized by irreversible damage and dilated bronchi, mainly associated with recurrent airway infection and inflammation [1,2]. It manifests with repeated respiratory infections, productive cough, shortness of breath, and decreased exercise tolerance [3]. Bronchiectasis presents a significant burden to the healthcare system due to its chronicity and increasing prevalence. It occurs due to repeated infections of the lower respiratory tract and altered mucociliary clearance, leading to stasis of secretions, infection, inflammation, and eventually destruction and dilatation of the peribronchial and bronchial tree [4]. The incidence and prevalence of bronchiectasis have increased by 40% worldwide in the past 10 years, with rates of 566 per 100,000 population reported in the UK in 2013 and 701 per 100,000 Medicare recipients in the USA. It is more common in the elderly, and frailer older patients tend to have more symptomatic diseases. In Asia, the bronchiectasis prevalence rate is 7%. A recent Indian study (n=680) identified post-infection (41%) as the primary cause of bronchiectasis [5]. Bronchiectasis is a progressive condition characterized by dilated, thick-walled bronchi. Patients with non-cystic fibrosis bronchiectasis exhibit persistent or recurrent bronchial infection related to irreversibly damaged bronchi, with symptoms including cough, sputum production, wheeze, shortness of breath, and decreased exercise tolerance [6]. The development of bronchiectasis occurs through Cole's vicious cycle, leading to impaired mucociliary clearance, making the lungs susceptible to chronic infection and colonization, and promoting an inflammatory response that persists even after infection has been controlled. Cole's "vicious cycle" has been central to the understanding of bronchiectasis progression since 1986. This considers the following components of the disease: airway infections, inflammation, mucociliary dysfunction, and structural lung damage. The objectives of treatment in bronchiectasis are to prevent exacerbations, reduce symptoms, improve airway clearance, and stop disease progression. Cough and sputum production, along with breathlessness, are frequent symptoms, but fatigue, hemoptysis, and thoracic pain are also common [7]. Medical management in bronchiectasis patients should include the following elements: (I) correction of any associated underlying disorder, if possible; (II) attention to general clinical care, including education on nutrition, maintaining a healthy lifestyle, and receiving appropriate vaccinations (against influenza and pneumococcal infections); (III) airway clearance therapies; (IV) anti-inflammatory therapies, if appropriate; (V) maintenance

antibiotics if required; (VI) treatment of exacerbations. Importantly, bronchiectasis is often characterized by airflow obstruction, which can significantly improve after the administration of bronchodilators [8]. Pharmacological management for bronchiectasis includes bronchodilators, antibiotics, and mucolytic agents. Surgical management options include double-lung transplantation, lung transplantation, and pulmonary lobectomy. Pulmonary function and exercise capacity often deteriorate over time, despite adequate medical interventions such as antibiotic treatment and bronchodilators [9]. For bronchiectasis with excessive sputum production, various techniques exist to clear secretions, such as postural drainage, positive expiratory pressure, autogenic drainage, lung flute, flutter device, and acapella device [10]. Airway clearance techniques are an important component of the management of patients with bronchiectasis, helping to remove secretions. They have been recommended for patients with chronic productive cough, where mucus plugging can be seen on CT-chest. Airway clearance techniques are expected to change the viscoelastic properties of secretions, increase gas-liquid relationships, and facilitate secretion removal. These effects are based on fluctuations in pulmonary volumes, pressures, and expiratory flows, the effect of gravity, or the application of compressive or vibratory forces, depending on the techniques used [11]. The Active Cycle of Breathing Technique is a commonly used airway clearance technique for bronchiectasis [11]. It facilitates the removal of excessive secretions from the lungs and is a combination of exercises consisting of three phases: breathing control, thoracic expansion exercises, and forced expiratory techniques. The Active Cycle of Breathing Technique can decrease narrowing of airways, increase oxygen saturation, and improve alveolar ventilation. Breathing control is a period of relaxed breathing at the subject's own rate. It comprises relaxed tidal breathing, which reduces the work of breathing, assists in recovery from shortness of breath, and prevents bronchospasm [12]. Thoracic expansion exercises comprise slow and deep inspiration with an inspiratory pause of about three seconds, which allows collateral ventilation, followed by a slow sustained exhalation. This technique is based on the phenomenon of interdependence. Forced expiration techniques involve one or two forceful huffs followed by a cough. It works on the principle of equal pressure point. With huffing, secretions are mobilized to the proximal airways, which are then expelled by coughing [13]. Acapella is a small hand-held device for airway clearance. It has both resistive and vibratory features, which help to loosen and clear secretions from the chest. This causes vibration and resistance to the airflow, which is then transmitted to the lungs. The resistance to the airflow helps to keep the airways open to get air behind the sputum and help it move upwards. The vibrations help to loosen secretions from the airways and move them up more easily for effective chest clearance [14]. Conventional chest physiotherapy aims to mobilize secretions and facilitate effective expectoration, providing control of cough and improving airway clearance. It is widely advocated as a mainstay of management for this chronic disease and is an integral standard of treatment for patients with bronchiectasis. Each patient was trained by the chest physiotherapist to complete three sets of the following cycle for each treatment session: 10 breaths followed by two to three forced expiratory techniques (huffs) or coughs [15].

2. Need of the Study

Bronchiectasis is a progressive respiratory condition characterized by the permanent dilatation of the bronchi, which causes impaired airway clearance and produces excessive sputum associated with clinical symptoms of cough with sputum production, decreased exercise capacity, and recurrent respiratory infections.

Various physiotherapy interventions are widely used in the treatment of bronchiectasis based on symptoms. Here, treatment for bronchiectasis aimed to improve airway clearance and exercise capacity. Studies have shown that both acapella and active cycle of breathing techniques have proven to improve airway clearance and exercise capacity in bronchiectasis. However, literature is limited to improving exercise capacity. Hence, the need for this study arises. Therefore, the purpose of this study is to determine the effect of acapella versus active cycle of breathing techniques on improving airway clearance and exercise capacity.

3. Aim of the Study

The aim is to find out the effect of acapella versus active cycle of breathing techniques to improve airway clearance and exercise capacity in subjects with bronchiectasis.

4. Objectives of the Study

1. To determine the effect of acapella on improving airway clearance and exercise capacity in subjects with bronchiectasis.

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2. To determine the effect of active cycle of breathing techniques on improving airway clearance and exercise capacity in subjects with bronchiectasis.
3. To compare the effect of acapella and active cycle of breathing techniques on improving airway clearance and exercise capacity in subjects with bronchiectasis.

5. Hypothesis

Research Hypothesis (H_r): Acapella is more effective compared to active cycle of breathing techniques in improving airway clearance and exercise capacity in subjects with bronchiectasis.

Null Hypothesis (H_0): There will be no significant difference between acapella and active cycle of breathing techniques in improving airway clearance and exercise capacity in subjects

6. Review of Literature

Dimili Vijaya Theresa et al. (2021) conducted a study on the effectiveness of the active cycle of breathing technique and slow expiration with glottis opened in lateral posture [ELTGOL] on the quality of life and functional capacity in subjects with bronchiectasis. They stated that recent evidence revealed that bronchiectasis is more common in women and elderly populations, causing an increased burden on healthcare. The incidence of bronchiectasis is 2-5 patients per 1000 population and is more common in elderly and older frailer patients, who tend to have more symptomatic diseases. A recent survey of 5.6 million patients showed a prevalence of 52 per 100,000 adults, with a prevalence of 272 per 100,000 for elderly aged >75 years. In Asia, the bronchiectasis prevalence rate is 7%. A recent Indian study (n=680) identified post-infection (41%) as the primary cause of bronchiectasis.

(European journal of pharmaceutical and medical research, 2021, 8(12), 419-426).

Saili Pednekar et al. (2023) conducted a comparative study on ELTGOL therapy versus ACBT on breathlessness, cough, and sputum production; exercise capacity; and quality of life in middle-aged bronchiectasis patients. This study aimed to compare the efficacy of the ELTGOL technique, a lesser-known but increasingly popular airway clearance technique, versus ACBT, the standard airway clearance technique, in improving pulmonary impairments, exercise capacity, and quality of life in middle-aged bronchiectasis patients. However, there was an insignificant difference between ELTGOL and ACBT in terms of improving pulmonary impairments, functional capacity, and health-related quality of life in middle-aged bronchiectasis patients.

(International journal of physiology, nutrition and physical education 2023; 8(1): 25-37).

Jennifer Phillips, Annemarie Lee et al. (2021) conducted a study on physiotherapists' use of airway clearance techniques in patients during an acute exacerbation of bronchiectasis: a survey study. This study noted that airway clearance techniques are recommended for individuals with bronchiectasis both in stable conditions and during an acute exacerbation. The aim of this study was to establish current physiotherapy clinical practice for adults and children during acute exacerbations of bronchiectasis, the effectiveness of airway clearance techniques, and to identify factors influencing treatment decisions in this population. The choice of technique and perceived effectiveness varied depending on the patient's age. All participants believed that directed huffing, physical exercise, oscillating PEP devices, ACBT, and PEP therapy were effective.

(Phillips et al., archives of physiotherapy (2021) 11:3).

Saurabh Semwal et al. (2015) conducted a study on "Autogenic drainage versus Acapella for airway clearance in patients with Bronchiectasis - Randomized control trail." In this study, a total of 30 patients with stable bronchiectasis were recruited and randomly assigned to two groups who were administered Acapella or Autogenic drainage clearance techniques in random order. The treatment duration for autogenic drainage was 20-30 minutes, and for Acapella, it was also 20-30 minutes, depending on the patient's requirement. The results showed no significant difference between the sputum weight and volume, dyspnea score, oxygen saturation, and peak expiratory flow rate in the Autogenic drainage treatment and Acapella treatment. They concluded that both Acapella and autogenic drainage are equally effective for sputum clearance in patients with bronchiectasis.

(International journal of health sciences and research 5(9), 323-327, 2015).

Vrushali K. Athawale et al. (2020) conducted a comparative study on the "Comparison of the Active Cycle of Breathing Technique (ACBT) versus Active Cycle of Breathing Technique with Flutter in Bronchiectasis." This study defined bronchiectasis as a permanent and abnormal dilatation of airways with an impairment of the mucociliary clearance mechanism that leads to inflammation and increased mucus production, noting it as a common disease with a high prevalence rate in industrial and rural populations. The objective of the study was to compare the active cycle of breathing technique (ACBT) versus the active cycle of breathing technique with flutter in patients with bronchiectasis. They concluded that ACBT and the flutter device show significant improvement in treating bronchiectasis patients, but when compared, both techniques are equally effective.

(National journal of medical research 10(04), 178-180).

Brittany L. Fell et al. (2021) conducted a study on "Six-minute walk test protocol variations in low-resource settings – a scoping review." This study stated that the 6-minute walk test is a validated tool of submaximal intensity used to objectively measure functional exercise capacity. In 2002, the American Thoracic Society (ATS) developed guidelines on standardizing the implementation of the 6MWT. Despite the relative ease of conducting the 6MWT as per these guidelines, adaptations are implemented.

(South African Journal of Physiotherapy 77(1), a1549).

Lidia Perea, Rosa Faner et al. (2024) conducted a study on the "Pathophysiology and genomics of bronchiectasis." This study described bronchiectasis as a complex and heterogeneous inflammatory chronic respiratory disease with an unknown cause in around 30–40% of patients. They noted that the presence of airway infection together with chronic inflammation, airway mucociliary dysfunction, and lung damage are key components of the vicious vortex model that better describes its pathophysiology. They concluded that since the bronchiectasis burden is increasing worldwide, clinicians and researchers need to keep working together to solve the knowledge gaps that remain in the understanding of pathophysiology, which is a crucial step towards precision medicine for allowing patients with bronchiectasis to benefit from new treatments.

(European Respiratory Review 2024 Jul 3;33(173):240055).

Hesham A. AbdelHali et al. (2016) conducted a comparative study on the "Comparison between active cycles of breathing with postural drainage versus conventional chest physiotherapy in subjects with bronchiectasis." They described it as a chronic debilitating condition with abnormal permanent dilatation of the airways causing impaired mucus clearance. Despite regular chest physiotherapy being a mainstay of management for bronchiectasis, they noted little evidence supporting its regular use. Chest physiotherapy aims to mobilize secretions and facilitate effective expectoration, providing control of cough and improving airway clearance. The objective of this study was to compare the efficacy of two techniques of chest physiotherapy: ACBT with postural drainage and conventional chest physical therapy, as a method of airway clearance in adults with productive bronchiectasis. They found that ACBT with postural drainage is more effective than conventional chest physical therapy management of bronchiectasis during infective exacerbation.

(Egyptian journal of chest disease and tuberculosis 65 (1), 157-165, 2016).

J.E. Patterson et al. (2007) conducted a comparative study on "Acapella versus usual airway clearance during acute exacerbation in bronchiectasis: a randomized crossover trail." In this study, the authors took 20 subjects and compared both techniques, concluding that the acapella device may facilitate long-term adherence to regular airway clearance.

(Chronic respiratory disease 2007; 4: 67-74).

James D. Chalmers et al. (2015) conducted a study on the management of bronchiectasis in adults. Formerly regarded as a rare disease, it is now increasingly recognized, and a renewed interest in the condition is stimulating drug development. Most physicians recommend mucus clearance as the mainstay of therapy in bronchiectasis. They concluded that the goals of treatment in bronchiectasis are to facilitate airway clearance, suppress bacterial infection, and prevent exacerbations, and that techniques have shown improvement in lung function.

(European respiratory journal 2015 45: 1446-1462).

A.R. Zakira, Ganeswara Rao Melam, Syamala Buragadda et al. (2012) conducted a study on the "Comparison of Autogenic Drainage and Airway Clearance Breathing Technique on FEV1, FVC, and PEFR in Chronic Obstructive Pulmonary Disease." This study included 30 subjects randomly allocated into three groups of 10 subjects each. Group A (n=10) received autogenic drainage, Group B (n=10) was given active cycle breathing therapy, and Group C (n=10) was the control group and received only medications. The treatment duration for both Group A and B was one session a day for 5 days a week for 4 weeks. Subjects were asked to carry out maximal inspiration followed by maximal forced expiration, and the pre- and post-values of FVC, FEV1, and PEFR were measured by Computerized Spirometry. Significant improvements were observed in FVC, FEV1, and PEFR values. They concluded that autogenic drainage and airway cycle breathing techniques are effective in the clearance of secretions, which are one of the causes of airway obstruction in these patients.

(World applied sciences journal 20(6): 818-822, 2012).

Fell, B.L., Hanekom, S. et al. (2021) conducted a study on "Six-minute walk test protocol variations in low-resource settings - a scoping review." The 6-minute walk test (6MWT) is a validated tool of submaximal intensity used to objectively measure functional exercise capacity. In 2002, the American Thoracic Society developed guidelines on standardizing the implementation of the 6MWT. Despite the relative ease of conducting the 6MWT as per these guidelines, adaptations are implemented. The study aimed to identify 6MWT adaptations to the ATS guidelines described in low-resource settings (LRS), the purpose of the adapted 6MWT, and the reported argumentation for making these adaptations in relation to the specific context. The results included a total of 24 studies, with the majority (n=18; 75%) conducted in lower-middle-income countries. The most common adaptation implemented was variation in course length. Eight studies provided a rationale for adapting the 6MWT, with space constraint being the most common reason. The most common reason for adapting the 6MWT in LRS was addressed through adaptations in course length and/or configuration. The results of this review suggest that the value of the ATS-guided 6MWT in LRS may need to be re-evaluated.

(South African journal of physiotherapy 77(1), a1549).

Lisa J. Franks, James R. Walsh et al. (2022) conducted a study on "Patient perspectives of airway clearance techniques in bronchiectasis." While airway clearance techniques (ACTs) are recommended for individuals with bronchiectasis, data suggests that the use of and adherence to ACTs is poor. This study aimed to identify patient perceptions regarding ACTs and factors affecting adherence. Twenty-four participants participated in semi-structured interviews. The main facilitators to using ACTs included a perceived health and quality-of-life benefit, a tailored approach to ACTs, and the use of self-management strategies. Main barriers included a lack of time and motivation, a lack of access to resources, and a lack of perceived health benefits. A number of factors were identified by participants that may help promote adherence, including combining and trialing different ACTs and receiving regular ACT reviews and education from physiotherapists, as well as having good social support. They concluded that, to assist the personalized prescription of ACTs, clinicians should consider these facilitators and barriers to help promote adherence and improve patient outcomes.

(Physiotherapy theory and practice, 1-11, 2022).

Rebacca H. McLeese, Katherine O'Neill et al. (2022) conducted a study on "Airway clearance treatment in bronchiectasis: feasibility of linking survey results to registry data and a survey of patients' and physiotherapists' practices." Noting limited data on airway clearance treatment practices, the study found it feasible to conduct an online survey with patients with bronchiectasis. The survey revealed that patients used ACTs when they were symptomatic rather than as a preventive management strategy, and that physiotherapists generally followed the bronchiectasis guidelines, using a stepwise approach to management. They concluded that this study provides up-to-date information on ACT practice throughout the course of the disease, and that future work should explore how to optimize ACT data collection to maximize the use of real-world ACT data in bronchiectasis research and inform priority airway clearance techniques research questions.

(European Journal of Open Respiratory 2023 March 20;9(2):00540-2022).

Anne E. O'Donnell, M.D. (2022) conducted a study on "Bronchiectasis—clinical review." The study defined bronchiectasis as a clinical syndrome characterized by cough and sputum production in the presence of abnormal thickening and dilation of the bronchial wall visible on lung imaging. According to the bronchiectasis severity

index, a score of 0 to 4 indicates mild disease, 5 to 8 indicates moderate disease, and a score of 9 or more indicates severe disease. On the FACED scale, which measures forced expiratory volume in one second, age, chronic infection, extent, and dyspnea, a score of 0 to 2 indicates mild disease, and a score of 5 to 7 indicates severe disease.

Regarding bronchiectasis diagnostic criteria, it has been concluded that clinical bronchiectasis is a heterogenous condition that manifests as a chronic cough in patients, highlighting the development of more rapid diagnostic methods and improved algorithms for the evaluation and treatment of patients with bronchiectasis.

(New England Journal of Medicine 2022;387:533-545).

Bilge Uzmezoglu, Gundeniz Altiay et al. (2018) conducted a study on the efficacy of flutter and active cycle of breathing techniques in patients with bronchiectasis: a prospective, randomized, comparative study. This home-based study, lasting for 4 weeks, compared the oscillating physiotherapy device Flutter and ACBT in 40 patients randomly assigned to two groups of 20 patients each. The effect of the two physiotherapy methods on sputum production, pulmonary functions, and quality of life was compared. They concluded that the Flutter device and ACBT represent effective home-based physiotherapeutic methods, with the Flutter device appearing to be more effective regarding sputum production.

(Turkish Thoracic Journal 2018; 19(3): 103-9).

Harpreet Ranu et al. (2011) conducted a study on "Pulmonary Function Tests" and stated that Pulmonary Function Tests are valuable investigations in the management of patients with suspected or previously diagnosed respiratory disease. They aid diagnosis, help monitor response to treatment, and guide decisions regarding further treatment and investigation. This review described routinely used investigations and discussed their clinical implications, concluding that Pulmonary Function Tests are an important tool in the assessment and evaluation of patients prior to major surgery.

(Ulster Med J 2011; 80(2): 84-90).

Arietta Spinou, Beatriz Herrero-Cortina et al. (2024) conducted a study on "Airway clearance management in people with bronchiectasis: data from the European Bronchiectasis Registry (EMBARC)." International guidelines recommend airway clearance management as one of the important pillars of bronchiectasis treatment. However, the extent to which airway clearance is used for people with bronchiectasis in Europe is unclear. The aim of the study was to identify the use of airway clearance management in patients with bronchiectasis across different countries and factors influencing airway clearance use. The study included 16,723 people with bronchiectasis from 28 countries. The active cycle of breathing technique was used by 28% of the participants, and airway clearance devices by 16%. The frequency of airway clearance management and techniques used varied significantly between different countries. Participants who used airway clearance management had greater disease severity and worse symptoms, including a higher daily sputum volume, compared to those who did not use it regularly. Hence, they concluded that only half of the people with bronchiectasis in Europe use airway clearance management, and the use of and access to devices, mucoactive drugs, and specialist chest physiotherapy appears to be limited in many European countries.

(European Respiratory Journal. 2024 Jun 6;63(6):2301689).

Nadia Afrin Urme, Fabiha Alam et al. (2019) conducted a study on the "Effectiveness of Active Cycle of Breathing Technique (ACBT) for the Patients of Bronchiectasis: A Narrative Review Study." Bronchiectasis is described as an abnormal, irreversible condition of the bronchus, causing recurrent inflammation and infection, and characterized by chronic cough and sputum. Its management aims to clear airways, and the active cycle of breathing is considered the utmost standard treatment in bronchiectasis patients as it can reduce dependency on drugs. The study aimed to explore the effectiveness of the Active Cycle Breathing Technique by reviewing articles. The review found that ACBT causes a decrease in the amount of cough and sputum and increases lung function and quality of life in bronchiectasis patients. Therefore, the overall review showed that while not superior to other techniques, it can be used as a most effective treatment technique for bronchiectasis patients.

(Journal Clinical Respiratory Disease and Care 2019, 5:2).

Stephen J. Halliday et al. (2020) conducted a study on "Six-Minute Walk Distance in Healthy Young Adults." The six-minute walk test (6MWT) is a commonly used clinical assessment of exercise capacity in patients with cardiopulmonary or neuromuscular disease, but normal values are lacking for young adults, who are frequent subjects of testing. The study included 272 young adults, ages 18–50, who underwent American Thoracic Society protocolized six-minute walk testing. This is in contrast to existing equations extrapolated from older subjects that predict increasing 6MWD in younger subjects. They concluded that established reference equations should be reconfigured to include data from young adults, as age has minimal effect on 6MWD in this population. Heart rate response may be a valuable measure of effort in normal subjects. Six-minute walk distance, as with pulmonary function and exercise testing, should have predictive equations across the spectrum of age to allow for accurate assessment of exercise limitation.

Respiratory Medicine. 2020; 165: 105933.

Sara Annoni, Angela Bellofiore et al. (2020) conducted a study on the effectiveness of chest physiotherapy and pulmonary rehabilitation in patients with non-cystic fibrosis bronchiectasis: a narrative review. The aims of this review of clinical trials were to evaluate the safety and effects on physiologic and clinical outcomes of airway clearance techniques (ACTs) and rehabilitation in NCFB patients compared to usual care. The study found no differences in effectiveness between the several techniques used, although humidification and saline inhalation were able to aid airway clearance. Pulmonary rehabilitation (PR) was associated with short-term benefits in exercise capacity, dyspnea, and fatigue. Exercise training seemed to improve quality of life and lower exacerbation rates, but long-term data were not available. Hence, they concluded that ACTs seem effective in increasing sputum volume, although no benefit in QoL or exacerbation rate has been shown, and there were no differences in effectiveness between several techniques used. From their perspective, ACTs should also be accompanied by global rehabilitation interventions involving educational aspects in the management of the disease.

(Monaldi Archives for Chest Disease 2020; volume 90: 1107).

Caroline H. Nicolson et al. (2017) conducted a study on "The Bronchiectasis Toolbox—A Comprehensive Website for the Management of People with Bronchiectasis." They noted that while the health burden of bronchiectasis is increasing worldwide, medical and physiotherapy treatment strategies have progressed significantly over the past decade. For this reason, clinicians require readily accessible current evidence-based information on the management of this condition. After launching in 2015, the website received 64,549 hits from over 100 countries, and the videos have been viewed 10,205 times in 89 countries. The Bronchiectasis Toolbox is presented as a comprehensive multidisciplinary resource accessible to health professionals worldwide who manage people with bronchiectasis and a unique solution to an educational need. Regular updates aim to ensure the website's continued relevance. In conclusion, the Bronchiectasis Toolbox is a unique solution to a pressing need that has been accessed by clinicians worldwide, providing relevant evidence-based updates to ensure the latest information is readily accessible in a single location, contributing to the ongoing education of health professionals caring for this patient population.

(Medical Sciences 2017, 5, 13).

Eun Lee, Kyunghoon Kim et al. (2024) conducted a study on "Evidence-based management guidelines for non-cystic fibrosis bronchiectasis in children and adolescents." Non-cystic fibrosis bronchiectasis is described as a chronic respiratory disease with high socioeconomic and medical burdens caused by diverse respiratory illnesses. Early recognition, active treatment of exacerbations, and prevention of further exacerbations are considered essential for improving clinical outcomes. However, evidence for the treatment and prevention of acute exacerbations of non-cystic fibrosis bronchiectasis, especially in children, is lacking. Therefore, evidence- and consensus-based guidelines for medical and nonmedical treatment strategies for non-cystic fibrosis bronchiectasis in children and adolescents were developed. These guidelines encompass evidence-based treatment recommendations as well as expert opinions, addressing crucial aspects of the treatment and management of non-cystic fibrosis bronchiectasis in children, including considerations for antibiotics and airway clearance strategies, particularly in areas where evidence may be limited. Hence, they concluded that these guidelines would help improve the clinical outcomes of children and adolescents with non-cystic fibrosis bronchiectasis, although large RCTs are required to improve the evidence base for each management strategy.

(Clinical Experimental Pediatrics Vol. 67, No. 9, 418–426 2024).

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Jordan Powner, Andrew Nesmith et al. (2019) conducted a study on whether the employment of an algorithm of care including chest physiotherapy results in reduced hospitalizations and stability of lung function in bronchiectasis. They noted a paucity of data on the long-term clinical effects of high-frequency chest wall oscillation (HFCWO) in the bronchiectasis population, while other therapies such as nebulized mucolytics and long-term antibiotics have proven benefits on quality of life and exacerbation rates. In this study, a treatment algorithm that included HFCWO as a component was initiated to see the long-term effects of the proposed algorithm on lung function, antibiotic use, and exacerbation rates. Sixty-five patients received the Smart Vest® HFCWO system and were enrolled in the algorithm for treatment during the study period. They concluded that standardized care for bronchiectasis involving an algorithm for mucociliary clearance that centers on the initiation of HFCWO may help to reduce lung function decline, the need for oral antibiotics, and the hospitalization rate.

(BMC Pulmonary Medicine (2019) 19:82).

Agnaldo Jose Lopes et al. (2015) conducted a study to assess the impact of various causes of bronchiectasis on clinical data, pulmonary function tests, and high-resolution computed tomography (HRCT). This cross-sectional study included 112 consecutive patients with bronchiectasis allocated to five groups: sequelae of tuberculosis, history of non-tuberculosis infection, cystic fibrosis (CF), primary ciliary dyskinesia (PCD), and rheumatoid arthritis. All participants underwent spirometry, whole-body plethysmography, measurement of the diffusing capacity for carbon monoxide (DLco), and HRCT. They concluded that in individuals with bronchiectasis, the pulmonary function abnormalities are associated with the etiology of the underlying disease.

(Clinical Medicine & Research Volume 13, Number 1: 12-19).

J.C. Costa and J.N. Machado et al. (2017) conducted a study on the Bronchiectasis Severity Index and FACED score for the assessment of the severity of bronchiectasis. They noted that bronchiectasis (BC) is a multidimensional and etiologically diverse disease, and therefore, no single parameter can determine its overall severity and prognosis. In this regard, two different validated scores are currently used to assess the severity of non-cystic fibrosis bronchiectasis (NCFB): the FACED score and the Bronchiectasis Severity Index (BSI). The study aimed to evaluate the etiology of NCFB and compare the results of the assessment of NCFB severity obtained via FACED and BSI scores. According to the FACED score, the study found 20 patients (50%) with mild BC, 15 patients (37.5%) with moderate, and 5 patients (12.5%) with severe BC. The frequency of patients with low, intermediate, and high BSI was 13 (32.5%), 13 (32.5%), and 14 (35%), respectively. Moreover, they observed a weak but statistically significant association between FACED and BSI scores. Thus, although different, the FACED score and BSI correspond to validated multidimensional indices that provide an accurate assessment of the severity and prognosis of this pathology. The study found a small but significant association between the two scales, with a tendency for patients to be classified with a higher BSI relative to the FACED. The currently available literature shows that the BSI is superior to FACED in predicting multiple clinically useful outcomes, including hospital admissions, exacerbations, quality of life, respiratory symptoms, exercise capacity, and lung function decline, providing a clinically relevant assessment of the severity of the disease.

(Pulmonology. 2018;24(3):149-154).

Simone K. Visser et al. (2018) conducted a study on the management of bronchiectasis in adults, describing it as a chronic lung disease of diverse etiology characterized by a clinical syndrome of chronic cough and sputum production and recurrent pulmonary exacerbations, defined radiologically by abnormal bronchial dilatation. The reported prevalence of bronchiectasis continues to increase worldwide, with recent prevalence estimates in the United Kingdom of 566 per 100,000 women and 485 per 100,000 men. A diverse range of conditions leads to the common pathological endpoint of bronchiectasis through a cycle of impaired mucus clearance, bacterial colonization, inflammation, and structural damage occurring in the airways. The choice of antibiotic should be guided by the goal of therapy, clinical severity, airway microorganisms and their antibiotic susceptibility (obtained from sputum or bronchoscopy samples), prior antibiotic response, allergies, and drug interactions. The objectives of treatment in bronchiectasis are to improve symptoms and quality of life, reduce exacerbations, and limit disease progression. They concluded that bronchiectasis is gaining recognition as an important chronic lung disease of increasing prevalence, placing a significant burden on the healthcare system and the individual. The goals of therapy are to improve symptoms, reduce exacerbations, and limit the progression of the disease, with effective airway clearance being the mainstay of treatment.

(Medical Journal of Australia 209 (4) j 20 Aug 2018).

Raja Dhar, Sheetu Singh et al. (2019) conducted a study on "Bronchiectasis in India: results from the European Multicenter Bronchiectasis Audit and Research Collaboration (EMBARC) and Respiratory Research Network of India Registry." They noted that bronchiectasis is a common but neglected chronic lung disease, with most epidemiological data limited to cohorts from Europe and the USA, and few data from low-income and middle-income countries. Therefore, the study aimed to describe the characteristics, severity of disease, microbiology, and treatment of patients with bronchiectasis in India. The Indian bronchiectasis registry is a multicenter, prospective, observational cohort study. Adult patients (≥18 years) with CT-confirmed bronchiectasis were enrolled from 31 centers. Patients with bronchiectasis due to cystic fibrosis or traction bronchiectasis associated with another respiratory disorder were excluded. From June 1, 2015, to Sept 1, 2017, 2195 patients were enrolled. Marked differences were observed between India, Europe, and the USA, with patients in India being younger and having more severe disease and distinct characteristics from those reported in other countries. The study concluded that it provides a benchmark to improve the quality of care for patients with bronchiectasis in India and presents unique epidemiological data for bronchiectasis in India that will be important to inform quality improvement efforts, future clinical trial design, and disease understanding.

(Lancet Glob Health 2019; 7: e1269–79).

7. Methodology

Study Design: Quasi-experimental study design

Ethical Clearance and Informed Consent: The study protocol was approved by the Ethical Committee of GSL Medical College & General Hospital (Annexure-I). The investigator explained the purpose of the study and provided the patient information sheet. The participants were requested to provide their consent to participate in the study (Annexure-II). All participants signed the informed consent, and the rights of the included participants have been secured.

Study Population: Subjects clinically diagnosed with mild to moderate bronchiectasis (according to FACED score)

Study Setting: The study was conducted at the Department of Respiratory Medicine, tertiary care teaching hospital, Rajamahendravaram.

Study Duration: The study was conducted during the period between 1st August 2023 to 31st July 2024.

Intervention Duration: 18 sessions, 3 times a week for 6 weeks.

Sampling Method: Systematic random sampling.

Sample Size: 70 subjects, calculated based on a prevalence of 7% bronchiectasis using the formula Z2PQ/L2 (where prevalence (P) = 7%, Q = 100-P = 93, Relative error (L) = 6% of P).

Group Allocation

- Group-A: Acapella combined with conventional physiotherapy (32 subjects)
- Group-B: Active cycle of breathing technique combined with conventional physiotherapy (32 subjects)

GROUPS	NO. OF SUBJECTS	TREATMENT

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GROUP-A	32	ACAPELLA WITH CONVENTIONAL PHYSIOTHERAPY
GROUP-B	32	ACTIVE CYCLE OF BREATHING TECHNIQUES WITH CONVENTIONAL PHYSIOTHERAPY

Materials Used

1. Consent form
2. Data collection sheet
3. Sitting stool
4. Pulse oximeter
5. Measuring tape
6. Acapella
7. Disposable mouth pieces

8. Criteria for Sample Collection

Inclusion Criteria

- Mild to moderate bronchiectasis Subjects (according to FACED score)
- Age between 30-65 years
- Gender- both male and females
- Stable clinical functional status
- Productive cough
- Ability to cough
- Absence of respiratory failure

Exclusion Criteria

- Chest pain
- Uncontrolled hypertension
- Hemoptysis
- Rib fracture
- Structural deformities
- Recent abdominal surgeries
- Asthma
- Respiratory failure
- Inability or unwillingness to sign informed consent.

9. Outcome Measures

Pulmonary Function Tests

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The functional indices measured were forced expiratory volume in one second (FEV1), forced vital capacity (FVC), and the FEV1/FVC Ratio. Special attention must be paid when FEV1 and FVC are concomitantly decreased and the FEV1/FVC ratio is normal or almost normal. Significant improvement in FEV1, FVC, or both would suggest the presence of reversible airflow obstruction. The FEV1 and FEV1/FVC ratio are the basic parameters used to properly interpret lung function. FEV1 has the advantage of being the most repeatable lung function parameter and one that measures changes in both obstructive and restrictive types of lung disease [16].

Figure-1 Pulmonary Function Tests

6 Minute Walk Distance

It is widely used to measure exercise capacity. The 6-Minute Walk distance was a submaximal exercise. Different variations of the timed walk have been tested, and the 6-minute timed walk was recommended given its reproducibility and ease of administration compared to longer timed tests (Fig-1). While the subject was seated and at rest, perceived exertion, heart rate, and blood pressure were measured and documented. The aim of this test is to walk as far as possible for 6 minutes. The subject must inform the therapist if they experience any chest pain or dizziness. A therapist demonstrates walking 30 meters out and back and can provide physical assistance (e.g., for balance or weight-shifting) [17].

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Figure-2 6-Minute Walk Distance

10. Intervention

Group A: Acapella Combined with Conventional Physiotherapy

The Acapella® device (Acapella DH Green, Smiths Medical ASD. Inc., Keene, NH, USA) is a small hand-held device for airway clearance [18]. It has both resistive and vibratory features, which help to loosen and clear secretions from the chest (Fig-2). This causes vibration and resistance to the airflow, which is then transmitted to the lungs. The resistance to the airflow will help to keep the airways open to get air behind the sputum and help it move upwards. The vibrations will help to loosen secretions from the airways and move them up more easily for effective chest clearance [19].

The subject was in a sitting position and instructed to breathe 10-12 times using the Acapella. Each inspiration was followed by a 2-3 second hold and exhalation. A cough or huff was performed after every 10 breaths. The treatment was given for a total of 20-30 minutes depending on the patient's requirements [20].

Treatment Duration: 3 times a week for 6 weeks (18 sessions) will be given, along with conventional physiotherapy.

Group B: Active Cycle of Breathing Techniques Combined with Conventional Physiotherapy

The active cycle of breathing technique is an airway clearance technique that focuses on controlling the breathing pattern and includes breathing control [21].

Subjects were made to sit comfortably on a stool in a sitting position.

- **Breathing control:** Subjects were allowed to breathe at a normal rate and depth using the lower chest (Fig-4(a)).
- **Thoracic expansion exercises:** Subjects were made to perform active shoulder flexion with deep inspiration and hold the breath for about 2-3 seconds. While returning to neutral, they were made to perform pursed-lip exhalation (Fig-4(b)). Similarly, subjects performed active shoulder abduction with deep inspiration and, while returning to neutral, performed pursed-lip exhalation. This continued for about 10 repetitions.

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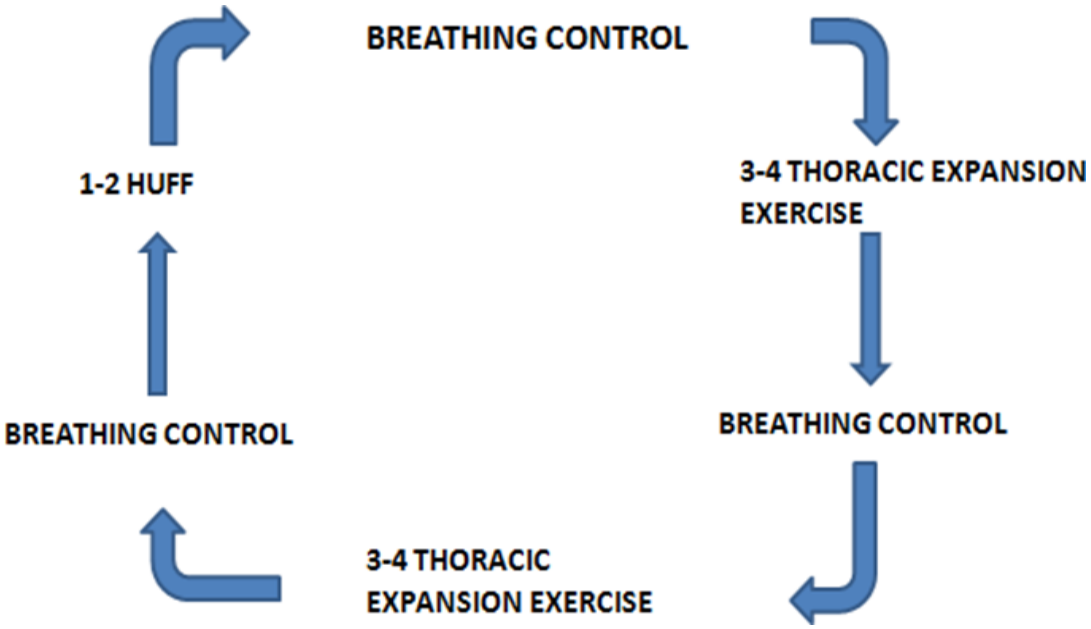

- **Forced expiratory technique:** Subjects were asked to take a deep breath and, while keeping the mouth open in an O shape, perform a forceful contraction using their abdominal muscles (huff). Patients were allowed to cough only after the end of the cycle with the forced expiratory technique (Fig-4(c)). After the patient was stable following one cycle of the active cycle of breathing technique, the next cycle was started. Each active cycle of breathing technique cycle lasted around 2 minutes, and the total treatment continued for up to 15 minutes [22].

Each active cycle of breathing technique cycle lasted around 2 minutes, and the total treatment continued for up to 15 minutes.

Treatment Duration: 3 times a week for 6 weeks (18 sessions) will be given, combined with conventional physiotherapy.

Conventional Chest Physiotherapy

Conventional Chest Physiotherapy is a most commonly used treatment intervention for patients with airway diseases. It improves mucus clearance, decreases the risk of pulmonary infection, and slows down the process of decline in pulmonary function [23].

Chest physiotherapy aims to mobilize secretions and facilitate effective expectoration, providing control of cough and improving airway clearance.

Percussion/Clapping was applied over a blanket or towel and performed with slightly cupped hands, applied alternately over the chest wall with a quick relaxed flexion and extension of the wrists. It loosens the secretions from the bronchial walls and is widely advocated as a mainstay of management for this chronic disease. Each patient was trained by the chest physiotherapist to complete three sets of the following cycle for each treatment session: 10 breaths followed by two to three forced expiratory techniques (huffs) or coughs [24].

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Figure-3 Acapella device

(a) Breathing control

(b) thoracic expansion exercises

(C) huffing and coughing

Figure-4 Active cycle of breathing techniques

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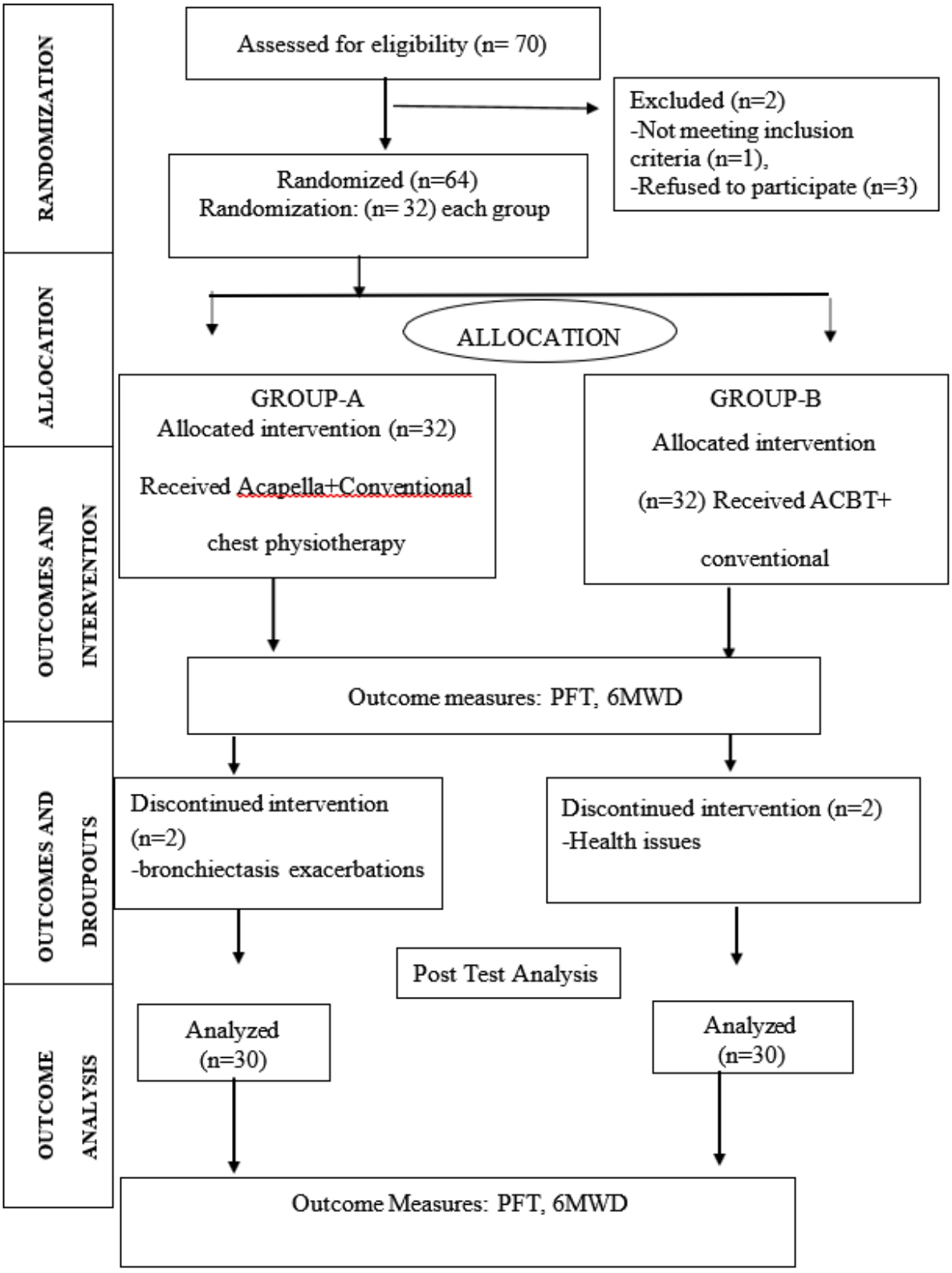
11. Flowchart



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12. Statistical Analysis

Statistical Analysis

All statistical analysis was done using SPSS software version 20.0 and MS Excel 2019.

All descriptive statistical data is presented as Mean ± Standard Deviation and percentage. Data was also tabulated and graphically represented.

Within the groups: A paired Student's t-test was performed to assess the statistical difference within the two groups for airway clearance and exercise capacity from pre-test and post-test values.

Between the groups: An independent Student's t-test was performed to assess the statistically significant difference in mean values between the groups for the pulmonary function test (for airway clearance) and the 6-minute walk distance (for exercise capacity).

Data was also tabulated and graphically represented. For all statistical analyses, $p < 0.05$ was considered statistically significant.

13. Results

The results of the study were analyzed using pulmonary function tests and the 6-minute walk distance to determine the improvement in airway clearance and exercise capacity.

The CONSORT flow chart of the study showed the study organization in terms of subject screening, random allocation, and analysis following the intervention.

A total of 70 subjects with bronchiectasis were screened for eligibility, among whom 64 subjects were included in the study trial. All 64 subjects underwent baseline assessment, and those who met the inclusion criteria were randomized into two equal groups: Group A consisted of 32 subjects, and Group B consisted of 32 subjects. In this study, 30 participants completed training in Group A, and 30 participants completed training in Group B, with 2 dropouts in each group.

14. Analysis of Mean Scores of Pulmonary Function Test from Pre-test to Post-test Within Group A

PFT		Mean	SD	P-Value	Inference
GROUP A	PRE	43.4	6.17	0.0001	highly Significant
	POST	59.71	7.32		

Table-1

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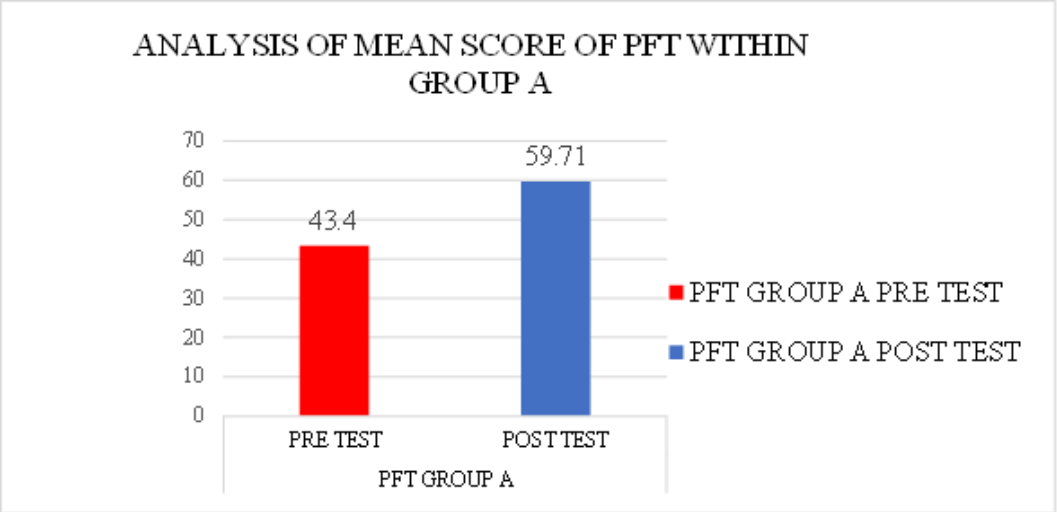


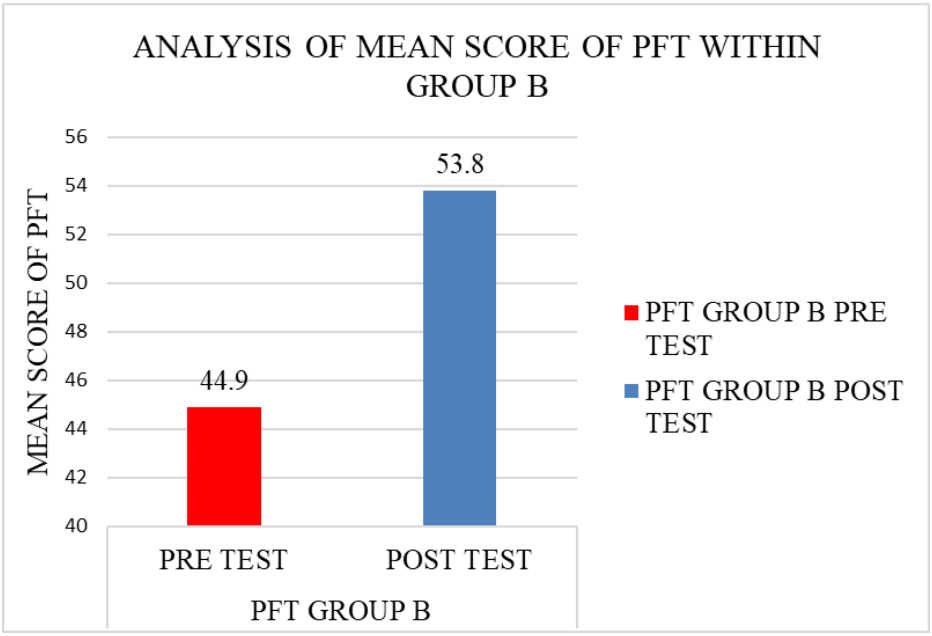
Graph-1

Results: The above Table and Graph shows that mean scores of Pulmonary function tests changes within the Group A from Pre-test to Post test were found to be statistically significant. (P- value<0.05).

15. Analysis of Mean Scores of Pulmonary Function Test from Pre-test to Post-test Within Group B

PFT		Mean	SD	P-Value	Inference
GROUP B	PRE	44.9	7.65	0.0001	Highly Significant
	POST	53.8	6.44		

Table-1



Graph-2

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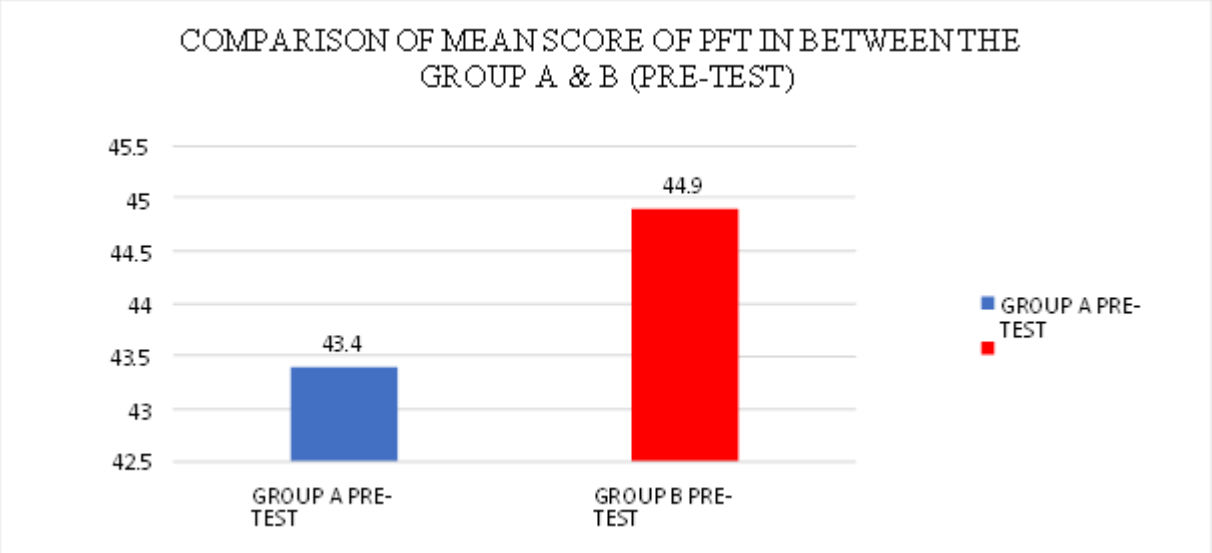
Results: From the above Table and Graph shows that mean scores of Pulmonary function Test changes within the Group B from Pre-test to Post test were found to be statistically significant. (P- value<0.05).

16. Comparison of Mean Scores of PFT Between Groups A & B (Pre-test)

PFT		Mean	SD	P-Value	Inference
PRE	GROUP A	43.4	6.17	0.4072	Insignificant
	GROUP B	44.9	7.65		

Table-3



Graph-3

Results: From the above Graph shows, it was noted that there was no statistically significant difference with p>0.05 at baseline values of mean scores of pulmonary function Test and at post test values were to be found statistically significant (p<0.05).

17. Comparison of Mean Scores of PFT Between Groups A & B (Post-test)

PFT		Mean	SD	P-Value	Inference
POST	GROUP A	59.71	7.32	0.0034	Very significant
	GROUP B	53.8	6.44		

Table-4

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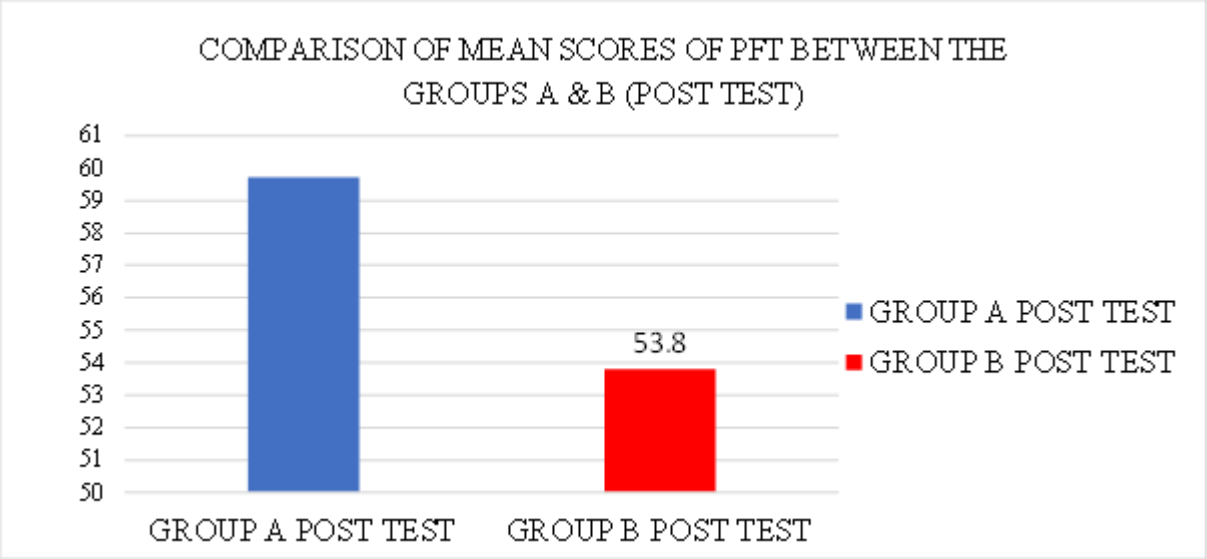


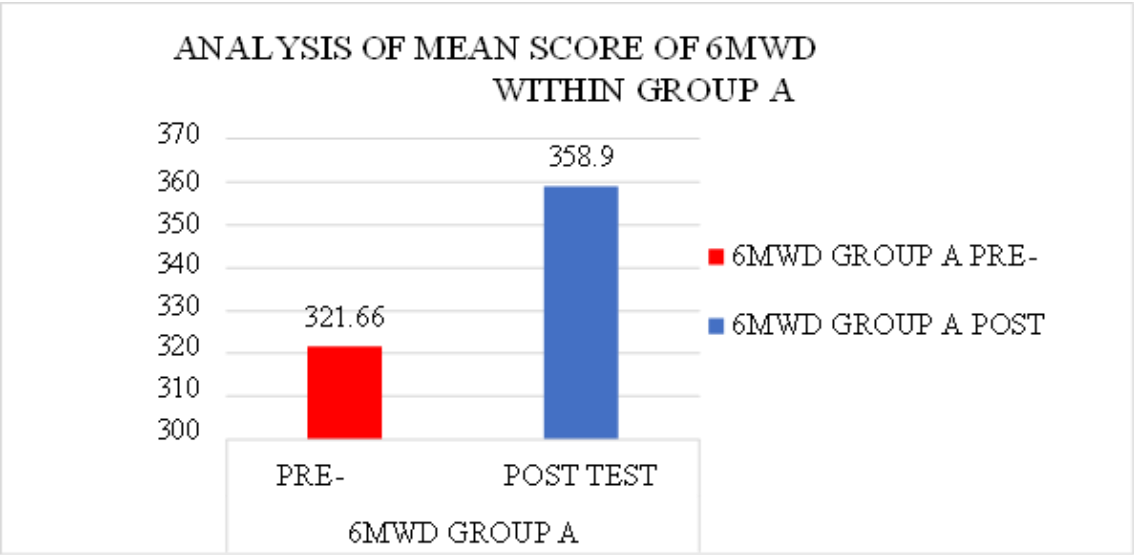
Graph-4

Results: The above table and graph shows that the Post-test measurements of MMRC mean scores in between the groups. MMRC mean score in Group-A is 2.225 and Group-B is 1.55 which were found to be statistically highly significant.

18. Analysis of Mean Scores of 6-Minute Walk Distance from Pre-test to Post-test Within Group A

6MWD		Mean	SD	P-Value	Inference
GROUPA	PRE	321.66	19.96	0.0001	Highly Significant
	POST	358.9	20.68		

Table-5



Graph-5

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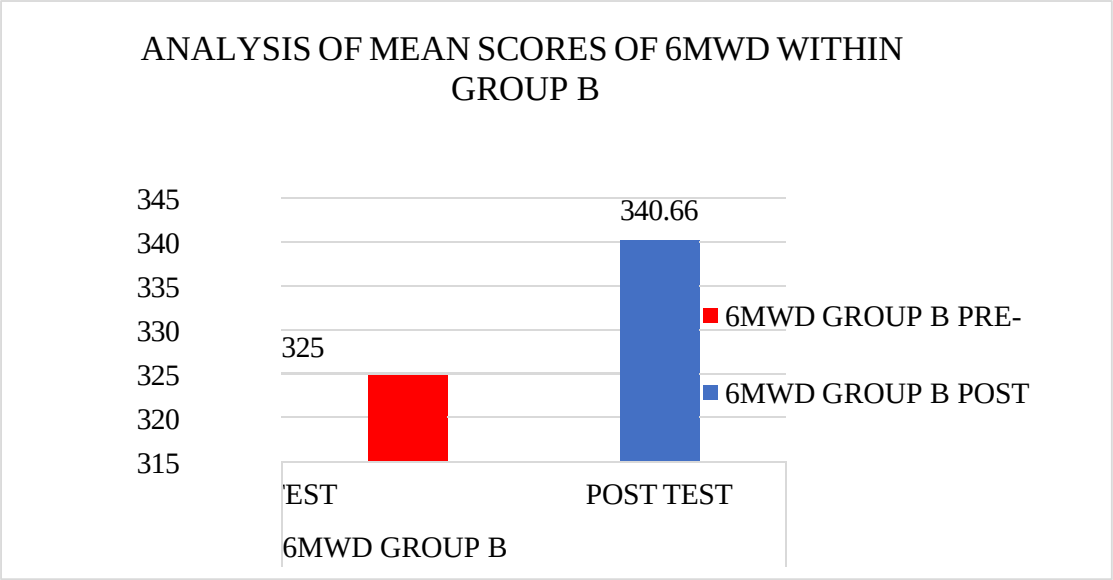
Results: The Above Table and the Graph shows that it means scores of 6-minute walk distance changes within Group A from Pre-test to Post test and were found to be Statistically Significant. ($p<0.05$).

19. Analysis of Mean Scores of 6-Minute Walk Distance from Pre-test to Post-test Within Group B

		Mean	SD	P-Value	Inference
GROUP B	PRE	325	20.29	0.0001	Highly Significant
	POST	340.66	20.62		

Table-6



Graph-6

Results: The above Table and Graph shows that mean scores of 6-minute walk distance changes within the Group B from Pre-test to Post test values and were found to be statistically significant. (P- value<0.05).

20. Comparison of Mean Scores of 6MWD Between Groups A & B (Pre-test)

6MWD		Mean	SD	P-Value	Inference
PRE	GROUP A	321.66	19.96	0.5239	Insignificant
	GROUP B	325	20.29		

Table-7

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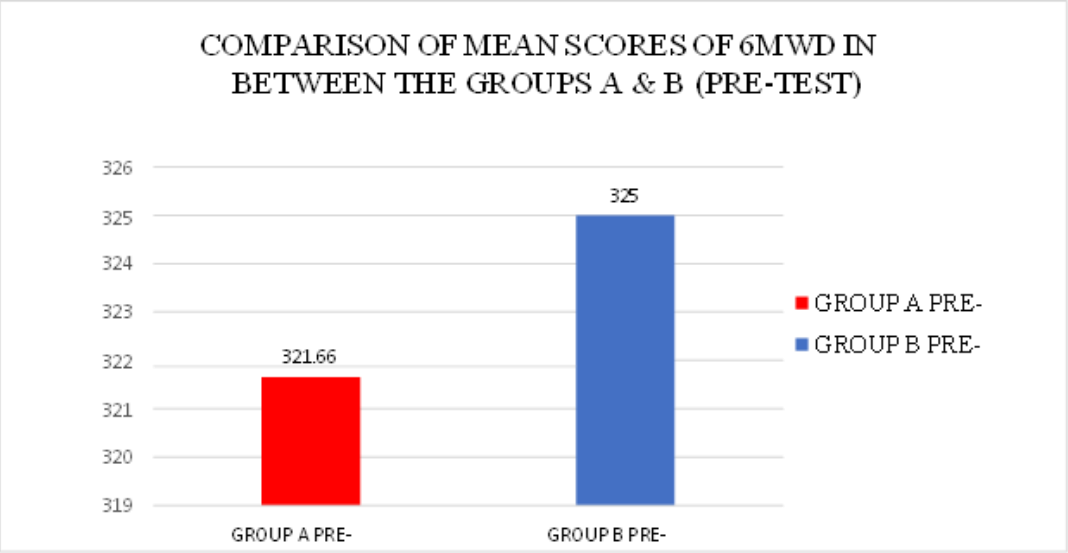


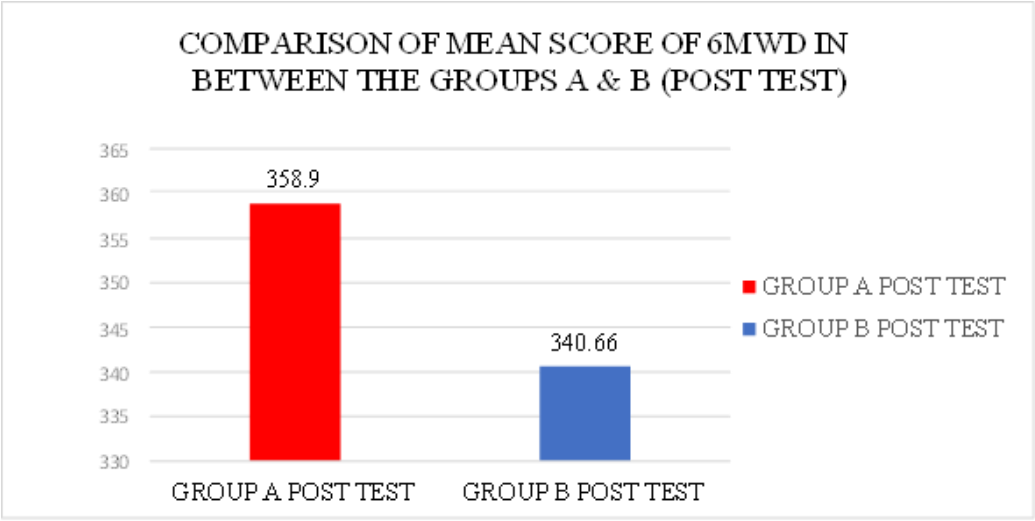
Graph-7

Results: The above table and graph shows that the baseline measurement of SGRQ mean scores in between the groups. SGRQ mean score in Group-A is 58.575 and Group-B is 58.05 which were found to be statistically insignificant.

21. Analysis of Mean Scores of 6MWD Between Groups A & B (Post-test)

6MWD		Mean	SD	P-Value	Inference
POST	GROUP A	358.9	20.68	0.0012	very significant
	GROUP B	340.66	20.62		

Table-8



Graph-8

Results: The above table and graph shows that the Post-test measurement of SGRQ mean scores in between the groups. SGRQ mean score in Group-A is 51.05 and Group-B is 40.4 which were found to be statistically highly significant.

22. Discussion

The present study aimed to evaluate the effects of the Acapella device versus active cycle of breathing techniques on airway clearance and exercise capacity in individuals with bronchiectasis. Previous studies have compared these two methods for improving airway clearance in bronchiectasis patients. To our knowledge, this study demonstrates that the Acapella device is more effective than the active cycle of breathing techniques in enhancing both airway clearance and exercise capacity in subjects with bronchiectasis.

In this study, subjects with bronchiectasis underwent intervention with either the Acapella device or active cycle of breathing techniques for six weeks. Parameters, including the 6-Minute Walk distance and Pulmonary Function Test, were measured before and after the interventions. These assessments were used to evaluate airway clearance and exercise capacity in the subjects. The results revealed a statistically significant difference between the pre- and post-intervention values for both the Acapella device and active cycle of breathing techniques, indicating improvements in airway clearance and exercise capacity after six weeks of intervention in subjects with bronchiectasis.

Previous studies, such as Wills et al. [25], have shown that bronchiectasis leads to a reduction in optimal levels of sodium and potassium, which are essential for mucociliary transport. This impairment in airway clearance increases sputum production, reduces exercise capacity, and causes progressive airflow obstruction. As a result, expiratory flow limitation occurs, increasing the work of breathing and physiologically reducing maximal mechanical power output, which reflects exercise capacity. Therefore, any improvement in respiratory symptoms may positively impact exercise capacity, commonly evaluated by the 6-Minute Walk Distance (6MWD). This measure is a validated and reliable indicator of functional capacity in patients with bronchiectasis [26].

A bench study by Teresa A. Volsko et al. [27] demonstrated that the performance characteristics of the Acapella are similar to those of the Flutter device, suggesting the Acapella device is an effective method for airway clearance in patients with bronchiectasis. The devices were compared in terms of mean pressure, pressure amplitude, and frequency. The Acapella device was found to produce higher amplitude oscillations at lower flow rates, making it potentially useful for patients with more severe lung function. Another study demonstrated that while Acapella and Active Cycle of Breathing Techniques (ACBT) were similar in terms of sputum production, a greater proportion of patients expressed a preference for the Acapella device [28].

Airway clearance techniques (ACTs) are routinely prescribed in clinical practice and recommended by international guidelines for individuals with bronchiectasis, especially during exacerbations. However, there is limited evidence investigating which specific ACT should be implemented [29]. A study examining airway clearance management in individuals with bronchiectasis highlighted a gap despite recommendations from major bronchiectasis guidelines that emphasize the importance of teaching airway clearance techniques and encouraging regular practice among patients. Notably, individuals with more severe bronchiectasis are more likely to receive airway clearance management [30].

23. Limitations

- Small sample size.
- Lack of control group in the present study.
- No blinding of the participants.
- Lack of follow-up.

24. Recommendations for Further Research

- The sample size can be increased with the inclusion of a larger number of subjects to generalize the effects of these techniques in a larger population.
- Further studies are recommended for long-term follow-up.
- The duration of the study can be increased to 8 weeks.

25. Conclusion

After six weeks of intervention, both the Acapella group and the active cycle of breathing techniques group showed significant improvement in airway clearance and exercise capacity among bronchiectasis subjects. However, the Acapella group along with conventional chest physiotherapy showed a greater percentage of improvement when compared to the active cycle of breathing techniques group. Hence, we conclude that Acapella is a convenient and suitable adjunct to Conventional Physiotherapy in improving airway clearance, thereby improving exercise capacity in subjects with bronchiectasis.

26. Summary

Title: Effect of Acapella Versus Active Cycle of Breathing Techniques to Improve Airway Clearance and Exercise Capacity in Subjects With Bronchiectasis.

Purpose: The purpose of the study was to determine the effect of Acapella and Active Cycle of Breathing Techniques in improving airway clearance and exercise capacity in subjects with bronchiectasis.

Methods: A quasi-experimental study design was used. 64 subjects with a mean age of 45 years and a clinical diagnosis of bronchiectasis were randomly allocated into two groups. Group A received Acapella, and Group B received Active Cycle of Breathing Techniques. Both interventions were administered for 18 sessions, 3 times a week for 6 weeks. The outcome parameters were measured using the Pulmonary Function Test (PFT) for airway clearance and the 6-Minute Walk Distance (6MWD) for exercise capacity in subjects with bronchiectasis.

Results: An independent t-test was used to compare the mean significance difference between continuous variables. A paired t-test was used to assess the statistical significance difference between pre- and post-test scores. Statistical analysis of the data revealed that within-group comparisons showed significant improvement in all parameters for both groups. However, between-group comparisons indicated that Acapella showed better improvement compared to Active Cycle of Breathing Techniques.

Conclusion: The present study concluded that after 6 weeks of intervention, both the Acapella group and the Active Cycle of Breathing Techniques group showed statistically significant improvements in airway clearance and exercise capacity. However, Acapella demonstrated greater improvement in PFT and 6MWD. Hence, we conclude that Acapella is a convenient, easy-to-use, and safe adjunct to improve airway clearance and exercise capacity in subjects with bronchiectasis.

Keywords: Acapella, Active Cycle of Breathing Techniques (ACBT), 6-Minute Walk Distance (6MWD), Pulmonary Function Test (PFT).

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