ORIGINAL ARTICLE

IJPHY

# Efficacy Respiratory Physiotherapy On Allergic Bronchopulmonary Aspergillosis. A Case Report

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## ABSTRACT

***Background:*** Allergic bronchopulmonary aspergillosis (ABPA) is a disease characterized by reversible airway obstruction. The clinical symptomatology involves recurrent episodes predominantly in subjects with asthma, those with cystic fibrosis, and subjects with bronchiectasis.

***Methods:*** A respiratory physiotherapy treatment plan of home training with The Acapella DH® provides the oscillatory positive expiratory pressure (OPEP) and POWERbreathe Plus® for two weeks, five days a week, twice a day (10 minutes in the morning and another 10 minutes in the afternoon) and to analyze the effectiveness of respiratory therapy using spirometry, as a treatment for a clinical case suffering from allergic bronchopulmonary aspergillosis, bronchial asthma, and bronchiectasis.

***Results:*** The first spirometric assessment carried out on week zero revealed that after the home treatment plan in week one and week two assessments, a significant increase in all spirometric lung function values was assessed with % change, such as Vital Capacity (VC), resulting in week 1 (0.80%) week 2 (1.09%), Tidal Volume (VT) resulting in week 1 (0.91%) week 2 (1.04%), Expiratory Reserve Volume (ERV) resulting in week 1 (1.14%) week 2 (1.24%), Inspiratory Reserve Volume (IRV) resulting in week 1 (0.66%) week 2 (1.04%) and Inspiratory Capacity (IC) resulting in week 1 (0.69%) week 2 (0.71%), together with decreasing respiratory times; inspiratory time (Ti) resulting in week 1 (-0.31%) week 2 (-0.38%), expiratory time (Te) and total inspiratory and expiratory time (Tt) resulting in week 1 (-0.24%) week 2 (-0.31%).

***Conclusions:*** A home pulmonary treatment plan with OPEP and POWERbreathe Plus® shows a clear improvement in lung function in subjects with ABPA, bronchiectasis, and asthma, thus improving quality of life.

***Keywords:*** Physiotherapy techniques, spirometry, allergic bronchopulmonary aspergillosis, capacity inspiratory.

Received 15th November 2021, accepted 28th February 2022, published 09th March 2022

10.15621/ijphy/2022/v9i1/1148

www.ijphy.org

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## INTRODUCTION

Aspergillus is a fungus that can opportunistically enter the human respiratory tract. It generally lives in soil or vegetation in a putrefactive state; however, it can be dispersed through the air in the form of spores, making it ubiquitous [1]. It can be found as a saprophyte in the bronchial tree. It can also be responsible for several lung diseases, such as allergic bronchopulmonary aspergillosis, which can occur in subjects with bronchial asthma, a rare disease whose prevalence varies from country to country [2].

The first three cases of ABPA were reported by Hinson, Moon, and Plummer (1952) in England [3]. Denning and cols. (2013) [4] estimated the prevalence of ABPA in adults with asthma to be 2.5% (range 0.72-3.5%), concluding that the global prevalence burden of ABPA potentially exceeds 4.8 million people.

Some subjects present with a single disease outbreak, while others develop repeated episodes with bronchiectasis and retraction of the upper lobes, as evidenced by radiodiagnostics[1]. ABPA bronchiectasis is characteristic as bronchial dilatation appears in the proximal zone, with the distal bronchial tree remaining practically normal [5].

Respiratory physiotherapy educates the respiratory pattern through specific respiratory muscle exercises, individually designed, based on relieving respiratory symptoms, increasing exercise tolerance, and improving quality of life [6]. It also reduces complications and medical budgets, improving resilience and social participation. Respiratory physiotherapists use specific tools for patient recovery, such as Acapella DH®, which provides the oscillatory positive expiratory pressure (OPEP), the principle function as a mucus clearance device is based on its ability to: vibrate the airways, intermittently increase endobronchial pressure and accelerate expiratory airflow[7]; POWER breathe Plus® (BIOCORP EUROPA SL.), adjustable resistance on the inspiratory musculature, therefore, it is a muscle strengthening system, thus favoring gas exchange in the blood [8].

## MATERIALS AND METHODS

### Description of the case

A 67-year-old woman diagnosed with ABPA, asthma, and bronchiectasis, with medical treatment from the hospital complex in Avila, consisting of treatment with CEFTAZIDIMA half a gram (5ml), every 12 hours nebulized by e-flow, attended the Catholic University of Avila for spirometry assessment and treatment employing breathing exercises at home.

The human research committee approved the study of the Ávila Health Area-Spain (GASAV/2019/11). The subject signed informed consent before they participated in the study. The trial was prospectively registered at ClinicalTrials.gov (NCT04748900)

### Study design

Firstly, an initial spirometry assessment was carried out using the DATOSPIR touch spirometer with a disposable Lilly mouthpiece, with the patient seated upright on a stool and with her feet resting on the floor, following the recommendations of the Spanish Society of Pneumology and Thoracic Surgery (SEPAR) and with a nose clip according to the American Thoracic Society and European Respiratory Society Technical Statement. The home treatment plan [9] was then explained by the research team, with a duration of 2 weeks, in which the proposed exercises were performed every five days a week (Monday to Friday), twice a day for 10 minutes in the morning and another 10 minutes in the afternoon, with control spirometry measurements every seven days.

### Spirometry test

Maintaining an upright posture at all times, we proceed to explain what the test will consist of, performing a slow vital capacity test, in which the patient will have to perform; breath calmly through the mouthpiece, at least three breaths, until verifying that the baseline (FRC) is stable; breathe in until TLC, and blow out slowly until residual volume (RV), with the patient visualizing her breaths on the computer monitor observing the axes (volume/time), with a maximum test time of forty-five seconds, repeating the test three times, with breaks of one minute between tests and acquiring the best test of the three [10,11].

### Home treatment plan

The research team then proceeded to demonstrate the use of the Acapella DH® and POWER breathe Plus® respiratory tools. Next, the patient underwent respiratory therapy with Acapella DH® to free the airways and specifically work on expiratory ventilatory mechanics.

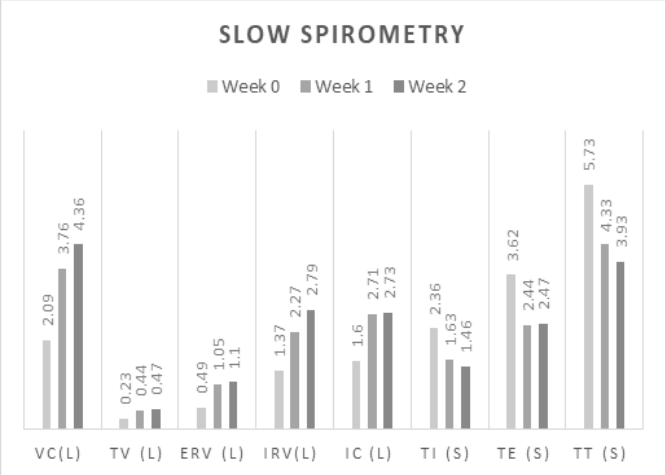
The patient is instructed to inhale slowly to a volume slightly larger than the TV through the mouthpiece and perform an inspiratory breath-hold for 2 to 3 seconds, thus promoting homogeneous ventilation [12]. After holding the breath and closing the glottis, the individual is instructed to exhale, with the glottis open against slight expiratory resistance through the Acapella DH®, at a slightly faster rate than usual. This is repeated consecutively five times with a rest of 30-50 seconds between repetitions, adjusting the frequency, amplitude of vibration, and positive expiratory pressure to level 2 out of 5.

Finally, after the established rest, the inspiratory musculature is worked; specifically, the diaphragmatic component with the POWER breathe Plus® [13] tool, in which 30 breaths are taken with slow exhalations, followed by a rapid and forceful inspiration through the mouth, with resistance or level 3 (41 cmH2O) The International System of Units [14].

## RESULTS

In this clinical case, the first spirometry assessment (Table 1) carried out on week 0 revealed a significant decrease in all spirometry values of lung function (VC, TV, ERV, IRV, IC), expressed in liters (l), together with an increase in respiratory times; inspiration time (Ti), expiration time (Te) and total inspiration and expiration time (Tt) expressed in seconds (s). (Fig. 1.).

**Figure 1:** Results in the Slow Spirometry.




After accepting and implementing the home treatment plan, a spirometry assessment was carried out over the following two weeks (week 1, week 2) with a gradual improvement in spirometry values and decreased inspiratory times.

This improvement was assessed by means of the % change (Table 2), taking the pre-study value in week 0 and comparing it with week one and week 2; the result was that all lung function values such as VC, TV, ERV, IRV, IC obtained positive values, giving information on the significant improvement of these lung functions, being more striking in week two and even comparing week 1-week 2, improvements in change were obtained.

**Table 1:** Respiratory Outcome Measures at weeks 0, 1 and 2

| | VC (l) | TV (l) | ERV (l) | IRV (l) | IC (l) | Ti (s) | Te (s) | Tt (s) |
|---|---|---|---|---|---|---|---|---|
| Week 0 | 2,09 | 0,23 | 0,49 | 1,37 | 1,6 | 2,36 | 3,62 | 5,73 |
| Week 1 | 3,76 | 0,44 | 1,05 | 2,27 | 2,71 | 1,63 | 2,44 | 4,33 |
| Week 2 | 4,36 | 0,47 | 1,10 | 2,79 | 2,73 | 1,46 | 2,47 | 3,93 |

It should be emphasized that these improvements in lung function led to improvements in lung times, these results being negative as a percentage, as they have been reducing times, compared to week 0, except in week 1-2 (0.01s).

After these results were obtained, they were evaluated by the % change between weeks, as week 0 - week 1; week 0 - week 2; week 1-2.

**Table 2:** % Change in lung function

| | VC (l) | TV (l) | ERV (l) | IRV (l) | IC (l) | Ti (s) | Te (s) | Tt(s) |
|---|---|---|---|---|---|---|---|---|
| %CHANGE week 0-week 1 | 0,80 | 0,91 | 1,14 | 0,66 | 0,69 | -0,31 | -0,33 | -0,24 |
| %CHANGE week 0-week 2 | 1,09 | 1,04 | 1,24 | 1,04 | 0,71 | -0,38 | -0,32 | -0,31 |
| %CHANGE week 1-week 2 | 0,16 | 0,07 | 0,05 | 0,23 | 0,01 | -0,10 | 0,01 | -0,09 |

## DISCUSSION

This clinical case is unique, as no similar study using the same treatment tools was found. However, it is very encouraging that very short-term benefits were obtained after performing the week 0 assessment as a pre-study value and the control assessments of the home respiratory physiotherapy treatment protocol in weeks one and two because of the patient's respiratory training.

In the IRV parameter in the initial test week 0, the patient achieved a value of 1.37 l; after the 5-day home training in week 1, she achieved 2.27 l, i.e., a % change of 0.66%, after the following week 2, she achieved 2.79 l, a % change compared to week 0 of 1.04%, giving us to understand as [15], that the specific work of the inspiratory musculature improves performance, even in people over 60 years of age, thus showing that the POWER breathe Plus® tool helps the inspiratory musculature, such as the diaphragm and external intercostals, in a very positive way.

Consequently, the VRE was observed in week 0 with a measurement of 0.49 l; after the relevant training, week one was assessed with a measurement of 1.05 l, with a % change of 1.14% concerning week 0; after the first week, the measurement was retaken in week 2 giving values of 1.1 l with a percentage change from week 0 of 1, 24%, the comparison between week one and week two is 0.05%, but without forgetting the maintenance of the VRE and even the slight improvement shown between the two weeks, this increase in VRE may be due to the specific work of the expiratory muscles without high resistance load plus mucolytic release as in the study by Milan S et al., [16] using positive expiratory pressure (PEP) and OPEP in subjects with chronic obstructive pulmonary disease (COPD), determined an improvement in expiratory volumes, together with an increase in quality of life indicators, thus decreasing their hospital stay. Furthermore, the increased muscle tone of the internal oblique and transverse abdominis muscles, as determined by Ishida H et al. [17], recommends high expiratory velocities for improvement in a rehabilitation program.

The improvements in the IRV and ERV are transferred to the VC with an initial value in week 0 of 2.09 l, increasing in week 1 3.76 l, being a % of change of 0.80%, and continuing to improve in week 2 with a value of 4.36 l being % of change with a difference to week 0 of 1.09%, finally between week 1 and 2 the % of change is 0.16%; The changes shown in VC suggest that the joint work of inspiratory and expiratory volumes as determined by Chen X et al. [18], improving VC, but working only one ventilatory pattern, does not demonstrate improvement.

The TV is also committed to certain normality since Pierce R. [19] determines that normality in healthy people is in men at around 0.5 l and in women at around 0.3 l, as observed in the comparison of week 0.23l, week one at 0.44l, and week two 0.47l, reaching changes in % change of 0.91% in week 1 and 1.04% in week 2, also having a % change in week one and week 2 of 0.07%.

With improvements in VRI and VT, the relationship of both will show an increase in HF, as determined by Varol Y et al. [20] in their study of a rehabilitation program improved HF in subjects with COPD, as demonstrated by an initial week 0 of 1.6l, week 1 of 2.71l and week 2 of 2.73l, with a % change in week 1 of 0.69% and week 2 of 0.71, resulting in

a difference between the two weeks of treatment of 0.01%.

Finally, the normalization of respiratory cycles 1:2 due to improved lung function, as determined by Middleton S.[21], observing decreases in Ti and Te so that the % change as discussed above will appear negative, as shown in Ti; at the beginning of week 0 of 2.36 s, decreasing in week 1 1.63 s and week 2 with 1.46 s, being a negative % change in week 1 of -0.31% and week 2 of -0.38%, so the % change between week one and week 2 is 0.10%; The following is observed at the beginning of week 0 with 3.62 s, decreasing in week 1 with 2.44 s and week 2 with 2.47 s, with a negative % change in week 1 of -0.33% and week 2 of -0.32%. Hence, the % change between weeks one and 2 is 0.1%. These results are transferred to the sum of both times in the Tt, observing a decrease, with an initial week 0 of 5.73 s, decreasing in week 1 of 4.33 s and week 2 of 3.93 s, establishing a negative % change as observed in week 1 of -0.24 s and week 2 -0.31, so the % change between weeks one and two is -0.09 %.

Among the study's strengths is that the patient has collaborated adequately both in the assessment and in the proposed treatment plan. In addition, there is a low percentage of bias, as the data were obtained under controlled conditions (space, time, materials, and assessment technique), and the data were analyzed accurately.

The study's limitations were the non-performance of forced spirometry (due to patient fatigue in this test) to obtain more data, the duration of the treatment, which was two weeks, and the non-measurement of maximum inspiratory pressure standardize the POWER breathe Plus® resistance.

## CONCLUSIONS

It is evident that a specific home respiratory treatment protocol according to the pathology is fundamental; the use of the Acapella DH® is a method of easy use and understanding in subjects with bronchiectasis, being fundamental to the main action of OPEP, thus freeing the airways and working the expiratory musculature without resistance, to then carry out, with more significant efficiency work with resistance of the inspiratory musculature thanks to the POWER breathe Plus®, showing benefits in motor recruitment in pulmonary functions.

### Patents

This section is not mandatory but may be added if there are patents resulting from the work reported in this manuscript.

**Funding:** "There is no funding support for this project."

**Institutional Review Board Statement:** "The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the human research committee of the Ávila Health Area-Spain (GASAV/2019/11). The subject signed informed consent before they participated in the study. The trial was prospectively registered at ClinicalTrials.gov (NCT04748900)."

**Informed Consent Statement:** "Informed consent was obtained from all subjects involved in the study."

"Written informed consent has been obtained from the patient(s) to publish this paper.

**Data Availability Statement:** Department of Physiotherapy, University Catholic of Ávila, Ávila, Spain.

**Acknowledgments:** We would like to thank the patient for volunteering to carry out this study at the Fisiosalud Ávila clinic.

**Conflicts of Interest:** "The authors declare no conflict of interest."

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