



Article Type: Case Report

Received: 25/06/2020

Published: 07/07/2020

DOI: 10.46718/JBGSR.2020.02.000055

Efficacy of the Treatment of the Distal Lung in a Patient with Bronchiectasis using only Volume and Expiratory Airflow Strategies: A Case Report

Mariaconsiglia Calabrese¹, Marta Sessa^{2*}, Michele Aliberti³, Marina Ciriello⁴, Roberta Palumbo⁵, Marina Garofano^{6*} and Michele Ciccarelli⁷

¹Physiotherapy Degree Course, Department of Medicine, Surgery and Dentistry, University of Salerno, Italy

²Associazione Italiana Fisioterapisti and Società Italiana Fisioterapia e Riabilitazione; Italy

³Filomena Gambardella Foundation, Lungomare Cristoforo Colombo, Italy

⁴Physiotherapy Degree Course, Department of Medicine, Surgery and Dentistry, University of Naples Federico II, Italy

⁵Società Italiana Fisioterapia e Riabilitazione, Italy

⁶Società Italiana Fisioterapia e Riabilitazione, Italy

⁷Medicine, Surgery and Dentistry Department, University of Salerno, Italy

*Corresponding author: Marina Garofano - BPT, Società Italiana Fisioterapia e Riabilitazione – marinag90@inwind.it, Marta Sessa - BPT, Associazione Italiana Fisioterapisti and Società Italiana Fisioterapia e Riabilitazione - martasessa45@gmail.com

Abstract

Introduction: Respiratory physiotherapy and the use of Airway Clearance Techniques (ACTs) is fundamental in treating obstructive diseases, like bronchiectasis. Lots of recent studies show the importance of the expiratory airflow in the airway clearance as the principle of the movement of secretions, replacing the concept of gravity. This case report aims to verify the efficacy of a treatment carried out using the combination of volume and airflow strategies, without any aids or machines.

Case presentation: C.L., an Italian 54-year-old female, after two years of several investigations because of frequent bronchial infections, was diagnosed with bronchiectasis in 2014. The patient is followed from February 2017 to August 2018: she complained about constant, productive, and purulent cough and fatigue in the pursuit of activities of daily life. The first intervention included the use of a Positive Expiratory Pressure (PEP) aid, Expiration Lente Totale Glotte Ouverte en infra Latéral (ELTGOL), and IET (Increased Expiratory Technique): to the first follow up, following patient's preferences, this treatment has been modified, replacing the flutter with the RIM (Resistive Inspiratory Maneuver). The main outcome considered was: BORG scale for dyspnoea and fatigue, Medical Research Council (MRC) score, COPD Assessment Test (CAT) score to assess the impact of the disease on the quality of life, the sputum quantity, the respiratory rate, and the number of exacerbations per year.

Conclusion: A year after the beginning of the physiotherapy treatment, there was an improvement in the patient's quality of life (reduction of CAT score), in sputum amount and number of exacerbations. These results show that the use of aids or machines may not be necessary for compliant patients if expiratory flows and lung volumes-based approaches are used.

Keywords: Bronchiectasis; Airway clearance; Distal lung; Expiratory airflow

Abbreviations: CAT: COPD Assessment Test; MRC: Medical Research Council; HRCT: High-Resolution Computed Tomography; COPD: Chronic Obstructive Pulmonary Disease; ACTs: Airway Clearance Techniques; FET: Forced Expiration Technique; OPEP: Oscillating Positive Expiratory Pressure; ACBT; Active Cycle of Breathing Techniques; CT: Computed Tomography; ADL: Activities of Daily Living; HRCT: High-Resolution Computed Tomography

Background

Bronchiectasis is a chronic lung condition, characterized

by a pathological and permanent dilatation of one or more bronchi. This harm affects the usual mucociliar clearance,

resulting in persistent bronchial infection and a chronic inflammation of the airway: the relationship between these processes forms a vicious cycle, defined by Cole in 1986 [1,2]. *Pseudomonas aeruginosa*, *Haemophilus influenzae*, *Streptococcus pneumoniae*, *Staphylococcus aureus* are common pathogenic agents that cause bronchiectasis infection. The Gold Standard to diagnose bronchiectasis in the High-Resolution Computed Tomography (HRCT) [3]. Two types of factors may favor the occurrence of bronchiectasis: congenital factors, including Cystic Fibrosis, Immune Deficiency conditions, Kartagener's Syndrome, or acquired factors such as severe pneumonia, Chronic Obstructive Pulmonary Disease (COPD) and asthma, gastroesophageal reflux or inhalations from cigarette smoke. The most common symptoms are chronic cough, sputum of various quantities, recurrent chest infections, dyspnea, hemoptysis.

Treatment of bronchiectasis may be pharmacological (antibiotics, corticosteroids, mucolytics, bronchodilators), physiotherapy and in some special cases, surgical. The most recent guidelines [4] suggest the importance of Airway Clearance Techniques (ACTs) in patients with stable bronchiectasis: regular twice daily respiratory physiotherapy increases sputum expectoration, dyspnea, and cough symptoms and, in general, quality of life. ACTs have developed in the last thirty years, challenging the idea that secretions move by gravity [5] and showing the value of an expiratory airflow, directed in the cephalic direction and behind the obstruction, to help collect and remove secretions [6].

The most used techniques in patients with bronchiectasis are Active Cycle of Breathing Techniques (ACBT) and oscillating positive expiratory pressure (OPEP), like Flutter and Acapella, which are both effective [4]. In addition, it is recommended to consider gravity assisted positioning to improve the effectiveness of ACTs and the inclusion of the Forced Expiration Technique (FET) or huff for all these techniques. British Thoracic Society guidelines suggest considering patient preference and adherence [7]. It is important to customize the duration and frequency of treatment according to the needs of the patient: however, treatment longer than thirty minutes is not recommended. It is customary to consider the session over until two clear huffs or coughs are completed.

This case report adopts an approach based on studies in which the importance of a personalized rehabilitative intervention has been shown [4,8,9]. The combination of several strategies is necessary to allow the displacement of secretions from the distal part of the bronchial tree to the mouth: volume strategies work on distal portions,

exploiting the elasticity of the lung parenchyma, while flow strategies are more effective at the proximal level. Therefore, the rehabilitation intervention is built after a careful assessment, which allows you to identify the areas to be treated: the correct modulation of expiratory flows and volumes enables work on the portions most obstructed at that time. The situation may change, so the treatment will change too.

Case Presentation

Patient History

An Italian 54-year-old female, working as a dental hygienist and leads an active lifestyle; she follows a "Mediterranean" diet. She's not a smoker. The patient complains about:

- a. Chronic and productive cough for the whole day, especially in the late morning;
- b. Hemoptysis during cough in recent months;
- c. Fatigue in carrying out activities of daily living (ADL), especially during the uphill and/or faster gait.
- d. Anxious state regarding her condition of chronic cough and the difficulty of having to cough/expectorate in public.

The patient reports an episode of bronchopneumonia in youth, and recurrent bronchitis exacerbations since 2012. From December 2013 she was repeatedly treated, for accentuated bronchitis symptoms, with Levofloxacin and steroids. In March 2014, she was admitted to the Morgagni-Pierantoni Hospital in Forlì for further investigation: she was diagnosed with bronchiectasis using Computed Tomography (CT). On this occasion, the *Mycobacterium tuberculosis* complex DNA positive has been discovered using the bronchoscopy after a Broncho-Alveolar Lavage (BAL): from April 7th she was treated by anti-tuberculosis therapy, but she was diagnosed with a right pneumothorax two days later and treated by pleural drainage (removed on 21st of April). After discharge, she had repeated episodes of bronchitis exacerbations, with purulent sputum and fever.

In June 2015, she had a CT scan which further highlighted the presence of cylindrical bronchiectasis in the left middle lobe, lingula, and lower lobe and signs of atelectasis in both posterior basal regions. Until the end of 2015, the patient had frequent bronchitis with alternation between periods of good health and others of productive cough, fever, and asthenia. In January 2016 a High-Resolution Computed Tomography (HRCT) confirmed the

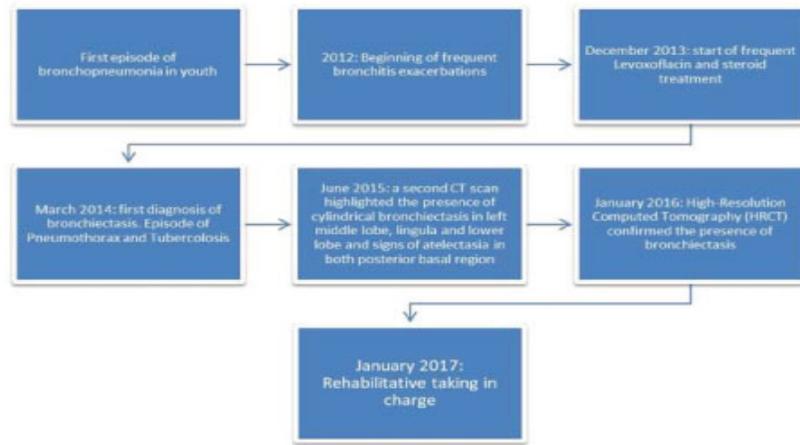


Figure 1: Timeline. Description of relevant dates and timing of the clinical case.

presence of bronchiectasis in the left lingula and lower lobe, and in the right medium and lower lobes too. In addition, it was possible to observe the presence of signs of flogosis and fibrotic rearrangement of the peri-bronchiectasic parenchyma. The patient was first initiated into respiratory physiotherapy, randomly, in January 2017: she had never had any other treatment (Figure 1).

First Physiotherapy evaluation

The patient was first evaluated in February 2017. She had previously carried out a cultural examination showing the presence of *Pseudomonas* spp. The patient comes walking: she appears alert and attentive. She does not use fixed therapeutic or monitoring devices. This evaluation shows:

- No cyanosis
- Normal muscle tone and no postural compensation.
- Good chest mobility
- Nasal breath
- No presence of Hoover's sign
- No asynchronous thoracoabdominal movements

Vital signs:

- Respiratory Rate in orthostatic position: 16; in supine position: 20
- Heart Rate: 75
 - i. O₂ Saturation
 - i. sitting position 97%
 - ii. supine position 96%

- iii. right side bed: 95%
- iv. left side bed: 94%

All the Pulmonary Function Tests (PFTs) result normal.

Table 1: First evaluation results. Abbreviations: COPD Assessment Test (CAT), Medical Research Council (MRC).

	Feb-17
Cough	Constant and productive
Dyspnea (Borg and MRC scale)	2-1
Physical fatigue (Borg scale)	3
Respiratory Rate in Ortho	16
Respiratory Rate in Supine	20
Sputum Quantity (ml/24h)	40 (brown)
O ₂ Saturation	≈ 95,5 %
CAT	25
N° exacerbations	≈ 1 every 2 months

Objective information:

- Chronic and productive cough
- Dyspnoea exertional (Borg scale = 2; MRC scale = 1)
- Brown purulent sputum (likely linked to the presence of *Pseudomonas* spp). Estimated amount: 40 ml/24h
- Fatigue (Borg scale = 3)
- No chest pain is found.

Auscultation: normal breath sounds with a slight left basal decrease, in-expiratory rales prevailing in left lateral

decubitus and some expiratory wheezes after coughing are found; It was decided to assess the impact of the disease on the quality of life of the patient through the CAT score, reaching a score of 25. The results of this first evaluation are resumed in the table below (Table 1).

Pharmacological Therapy

Until January 2017 and after the physiotherapy taking-over too, the patient followed a pharmacological treatment, with an average of one cycle every two months, only in cases of relapse. It includes:

- Antibiotic therapy;
- Aerosol therapy with Salbutamol sulfate, Beclomethasone, and sodium chloride solution, used to hydrate the secretion.

The patient is used to drink more than two gallons of water a day. For about a year, the woman has been using a device (Relvar) based on fluticasone furoate/vilanterol. This treatment has remained unchanged since the duration of taking charge.

Objectives and First Treatment Program

After this first evaluation, the following objectives have been defined:

- Short-term objectives: clear the airway easier;
- Medium-term objectives: ACTs learning;
- Long-term objectives: proper peripheral ventilation, effective self-treatment. To achieve these goals, the first treatment program is set up. It includes:

- **Flutter**

It is a very small pipe-shaped aid, consisting of a cone trunk containing a stainless-steel marble, which represents the strength of the system. A positive expiratory pressure (PEP) is produced by the patient, exhaling slowly and completely through the system; Flutter has also been demonstrated to be able to alter the rheological properties of secretions [10]. It is done in sitting position: the patient places the elbows on the table and, with one hand, holds the tool, keeping the mouthpiece between the lips, while with the other holds the cheeks remain firm while allowing the vibrations to be transmitted all at the level of the bronchial tree.

- **ELTGOL**

This technique uses slow Functional Residual Capacity

(FRC) to Residual Volume (RV) exhalation, then total slow expiration, with open glottis. ELTGOL is performed in lateral decubitus: the lung that reaches the best clearance is the inferolateral lung [11,12]. It's an active-assisted or active technique: active support can be applied with the therapist placed behind the patient, having one hand on the patient's abdomen and the other one on the patient's thorax. The therapist follows the slow expiration, using slow thoracic and abdominal or abdominal only compression to improve the lung deflation. The technique can also be carried out by the patient in full autonomy.

- **FET (huff)**

A maneuver used to move secretions, downstream towards the mouth; this technique should be included in any airway clearance routine [4].

- **Cough**

A reflex defense mechanism activated by irritating stimuli. In this specific order, these techniques were all performed during a single physiotherapy cycle. In our case, the patient is first supervised twice a week by the physiotherapist to learn and become independent of the implementing rules of treatment. The procedure will be done every day because the effects occur not immediately: secretions collected from the distal part of the bronchial

Table 2: Second evaluation results. Abbreviations: COPD Assessment Test (CAT), Medical Research Council (MRC).

	Aug-17
Cough	Episodic
Dyspnea (Borg - MRC scale)	2 -1
Physical fatigue (Borg scale)	2
Respiratory Rate in Ortho	15
Respiratory Rate in Supine	18
Sputum Quantity (ml/24h)	35 (yellow)
O ₂ Saturation	≈ 95,75 %
CAT	20
N° exacerbations	2 (March-June)

tree during the intervention may also be removed a few hours after treatment.

Follow up and outcome

Follow up have been established at six-monthly intervals. Outcomes evaluated are: type of coughs, dyspnea (assessed

by the Borg and Medical Research Council-MRC scales), fatigue (assessed by Borg scale), the respiratory rate in orthostasis and supine position, sputum color and quantity (collected in 24 hours), O₂ saturation, CAT questionnaire and number of exacerbations (whereas the patient, in the four months preceding the beginning of physiotherapy, had only had a single exacerbation). The second evaluation, in August 2017, showed the results reported in the table below (Table 2). The patient reports an improvement in exercise tolerance and in expectorating and cough less frequent but more intense: short-term objective has been reached.

Readjustment of physiotherapy treatment

At the same time, attention is given to the difficulties faced by the patient in the use of Flutter and her tendency to use ELTGOL and FET. She thinks those are more effective. Depending on the patient's preference, the Flutter is replaced by the Resistive Inspiratory Maneuver (RIM) used to treat the distal lung. This maneuver is usually carried out using a specific device that, placed at the mouth, creates a breath resistance: in our case it was unavailable, so the procedure was conducted slightly parting lips, making

seconds apnea allows greater recruitment of alveoli; finally, the patient breaths out up to Functional Residual Capacity (FRC). Immediately after RIM, the patient conducts ELTGOL, beginning from the FRC reached before: the procedure is conducted daily, alternating the two decubits in 10/15 minutes, to make use of pleural pressure differences in terms of volume and flow. In fact, while the RIM is useful for the expansion of the superolateral lung, the ELTGOL allows the maximum inferolateral deflation, so that, by alternating the two decubits, the lung is first inflated and then deflated in order to achieve the best clearance of the airway. The Flutter is still used by the patient but only once or twice a week. The patient started this new program in August 2017. The results of the next two follow up are shown in Table 3.

Results

In order to show the achievements of respiratory physiotherapy, all data collected have been shown in some graphs, starting from the first assessment in February 2017 to August 2018. The patient has achieved a good quality of life indicated by a decrease in the CAT score (Figure 2a) and an increase in fatigue and dyspnea according to the

Table 3: Follow up evaluation. Abbreviations: COPD Assessment Test (CAT), Medical Research Council (MRC).

	Feb-18	Aug-18
Cough	Episodic	Episodic
Dyspnea (Borg and MRC scale)	0,5-0	0,5-0
Physical fatigue (Borg scale)	1	1
Respiratory Rate in Ortho	12	12
Respiratory Rate in Supine	16	16
Sputum Quantity (ml/24h)	25 (white-yellow)	15 (white-yellow)
O ₂ Saturation	≈96%	≈ 96,25 %
CAT	14	8
N° exacerbations	1 (December 2017)	1 (August)

resistance as well. This technique is performed in lateral decubitus, to expand the superolateral lung, already expanded because of pleural pressure. After the RIM, a four-

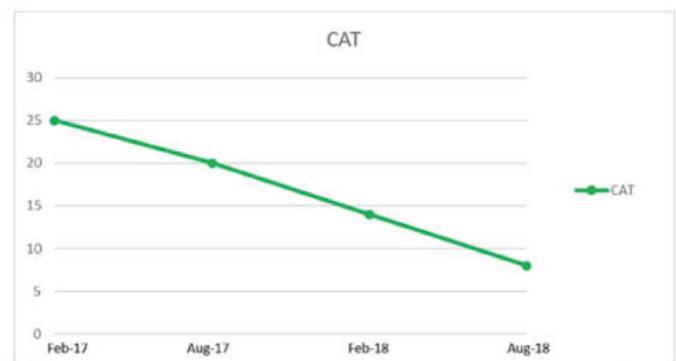


Figure 2a: The decline in CAT score (from 25 in February 2017 to 8 in August 2018) indicates a significant change in the patient's quality of life.

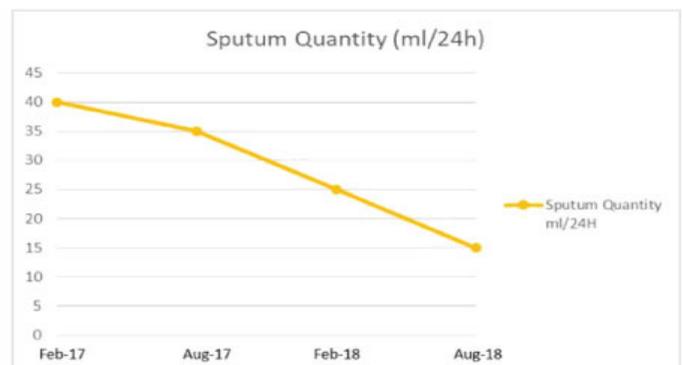


Figure 2b: The reduction in sputum volume is important as it represents a substantial increase in airway clearance.

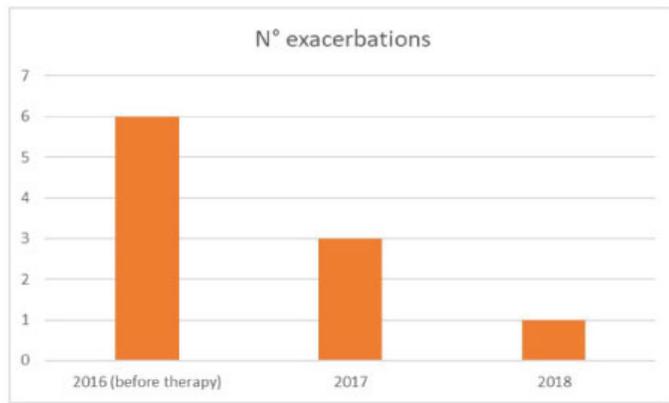


Figure 2c: The number of exacerbations per year is a long-term outcome of the effectiveness of the physiotherapy treatment.

BORG and MRC scales. This influences the respiratory rate, which is decreased both in orthostatic and supine positions. The amount of sputum decreased significantly: from 40 ml/24hrs in February 2017 to 15 ml/24hrs in August 2018 (Figure 2b). This impacts the number of exacerbations per year, from the average of a relapse every two months before recovery to just one relapse in 2018 (until August) (Figure 2c). The most significant of all graphs is the last one, which represents the number of exacerbations per annum. The reduction in the number of relapses shows the importance of day-to-day practice, especially about the learning of methods by subject, to encourage the break-up of the vicious circle, which is an integral part of the pathogenesis of bronchiectasis. Despite the remodeling of the first treatment set for February 2017, those results were achieved. However, the use of flow and volume strategies alone has allowed the patient to achieve good mucus ciliary clearance, without causing any worsening of symptoms.

Discussion

This case report makes us reflect on the importance of defining, through a preliminary assessment, the intervention that is most appropriate for the individual patient, combining the different strategies based on the problem. The patient has been treated basing on a study published by Postiaux [13], describing a "new paradigm" for the treatment of the distal lung. The bronchial tree is ideally divided into four different levels and the ACTs, considered to be equally valid [8], can be used each in a different bronchial compartment.

ACTs must be combined to carry secretions in cephalic direction, from distal airways towards the mouth. Therefore, we talk about airway clearance intervention and not just technique: Flutter and RIM are used for the treatment of the distal airway, ELTGOL acts on the central ones and FET allows

to move the secretions which are already more proximally. Finally, the cough removes the secretions through the mouth. In that way, there is a therapeutic continuum without aids, but only using inspiratory and expiratory flows, as described by Postiaux in the abovementioned study.

This type of approach could be useful in compliant patients, as in our case, who are able to carry out the techniques autonomously and then at home, ensuring the necessary therapeutic continuity to achieve the goals. The treatment varies according to the patient's conditions, which are valued daily: auscultation is seen as the critical tool for the first evaluation, during which the presence and the position of secretions are highlighted in order to choose the first technique to begin with. This tool is also useful for a reassessment to show the short and long-term efficacy of the approach used [14].

The results obtained by treating the clinical case show that respiratory physiotherapy is capable to improve patient's quality of life. The use of aids or machines, although indispensable in some diseases, especially in the neuromuscular ones, may not be necessary for compliant patients, if expiratory flows and lung volumes-based approaches are used. This is shown by the results obtained treating the clinical case examined, as an essential reduction of relapses and CAT score. Consideration should be given to the pharmacological treatment remained unchanged: it shows that the ACTs, added to the conventional therapy, are very useful.

Declaration of Interest Statement

The authors declare that there is no conflict of interest regarding the publication of this paper.

Informed Consent

The patient signed the informed consent which is available if required.

References

1. King PT (2018) The Role of the Immune Response in the Pathogenesis of Bronchiectasis. *Biomed Res Int* p. 1-12.
2. Nikolic A (2018) Pathophysiology and Genetics of Bronchiectasis Unrelated to Cystic Fibrosis. *Lung* 196(4): 383-392.
3. Altenburg J, Wortel K, van der Werf TS, Boersma WG (2015) Non-cystic fibrosis bronchiectasis: Clinical presentation, diagnosis and treatment, illustrated by data from a dutch teaching hospital. *Neth J Med* 73(4): 147-154.
4. Hill AT, Sullivan AL, Chalmers JD, De Soyza A, Elborn JS, et al. (2018) British Thoracic Society guideline for bronchiectasis in

-
- adults. *BMJ Open Respir Res* 5: 1.
5. Nelson HP (1934) Postural drainage of the lungs. *Br Med J* 2(3840): 251-255.
 6. Lazzeri M, Brivio A, Adone R, Zampogna E, Oliva G, et al. (1996) Intervento riabilitativo rivolto al polmone. In: *Riabilitazione respiratoria Nuovi Orientamenti*. Monza: Midia edizioni srl pp. 157-218.
 7. Hill AT, Sullivan AL, Chalmers JD, De Soyza A, Elborn S, et al. (2019) On behalf of the British Thoracic Society. *Br Thorac Soc Guidel Bronchiectasis Adults* 74: 1.
 8. Lester MK, Flume PA (2009) Airway-clearance therapy guidelines and implementation. *Respir Care* 54(6): 733-750.
 9. Strickland SL (2015) Year in review 2014: Airway clearance. *Respir Care* 60(4): 603-615.
 10. Tambascio J, de Souza HCD, Martinez R, Baddini-Martinez JA, Barnes PJ, et al. (2018) Effects of an airway clearance device on inflammation, bacteriology, and mucus transport in bronchiectasis. *Respir Care* 62(8): 1067-1074.
 11. Lannefors L, Wollmer P (1992) Mucus clearance with three chest physiotherapy regimes in cystic fibrosis: A comparison between postural drainage, PEP and physical exercise. *Eur Respir J* 5(6): 748-753.
 12. Postiaux G, Lens E, Alsteens G (1987) L'Expiration Lente Totale Glotte Ouverte en décubitus Latéral (ELTGOL) : nouvelle manœuvre pour la toilette bronchique objectivée par vidéobronchographie. *Ann Kinésithér* 14(7-8): 341-350.
 13. Postiaux G (2024) Chest physical therapy of the distal lung. Mechanical basis of a new paradigm. *Rev Mal Respir* 31(6): 552-567.
 14. Postiaux G (1984) La kinésithérapie respiratoire guidée par l'auscultation pulmonaire. *Kinésithérapie scientifique* p. 13-67.

***Corresponding author:** : Marina Garofano; Email: marinag90@inwind.it, Marta Sessa; Email: martasessa45@gmail.com

Next Submission with BGSR follows:

- Rapid Peer Review
- Reprints for Original Copy
- E-Prints Availability
- Below URL for auxiliary Submission Link: <https://biogenericpublishers.com/submit-manuscript/>