REVIEW ARTICLE

The use of oscillatory positive expiratory pressure devices: a systematic review

The use of oscillatory positive expiratory pressure (OPEP) devices: a systematic review

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SUMMARY

Introduction: The indispensable application of the best evidence in the treatment of patients with respiratory diseases that occur with an increase in the amount of production of tracheobronchial secretions. **Goal:** Update knowledge on the scenario of use of oscillatory positive expiratory pressure devices internationally.
Methods: Systematic review with randomized, controlled, crossover clinical trials, obtained from the PubMed, SciELO, Cochrane and UpToDate databases. 862 articles were found, 7 of which were included in the qualitative and quantitative analysis. Results: The *Flutter* device was predominantly used in outpatient clinics of university hospitals with adults diagnosed with bronchiectasis with an average age of 56.31 years. The treatment lasted ± 4.5 weeks and lasted approximately 25 minutes. **Conclusion:** The efficacy and effectiveness of OOAF devices are indisputable. Several studies with different methodologies were carried out and, unanimously, all concluded the satisfactory effects of the devices.

Keywords: Physiotherapy; Oscillatory positive expiratory pressure; Mucociliary clearance; Physiotherapy modalities.

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Supporting sources:
There were no supporting sources.

Conflict of interests:
The authors declare that they have no conflicts of interest.

Received on: 1 November 2023
Approved on: 11 December 2023
Publication Date: 10 July 2024.

DOI: 10.5935/2238-3182.2024e34202

ABSTRACT

Introduction: The indispensable application of the best evidence in the treatment of patients with respiratory diseases with increased tracheobronchial mucus production has led to the development of health technologies for the application of knowledge and skills organized in the form of devices, drugs, vaccines, procedures and systems to solve a health problem and improve the quality of life. **Objective:** The objective of this study was to update the knowledge about the real scenario of the use of international oscillatory positive expiratory pressure OPEP devices. **Methods:** Crossover randomized controlled trials were obtained from the PubMed, SciELO, Cochrane and UpToDate databases.

Found 862 articles, 7 of which were included in the qualitative and quantitative analysis. **Results:** Predominantly the Flutter device was used in outpatient clinics of university hospitals with adults diagnosed with bronchiectasis with average age of 56.31 years. Treatment was ± 4.5 weeks lasting approximately 25 minutes. **Conclusion:** The educational campaigns about the OPEP should be carried out, to make the target population aware of the importance of using the devices, as well as for health professionals, to rescue the use in clinical practice.

Keywords: Airway clearance; Oscillatory Positive Expiratory Pressure (OPEP); Phisiotherapy; Physical therapy modalities.

Introduction

Respiratory diseases impose an immense burden on global health, and four respiratory diseases are among the most common causes of death worldwide: chronic obstructive pulmonary disease (COPD), community-acquired pneumonia (CAP), pneumonia nasocomial and bronchiectasis1 .

Given this scenario, the importance of preventive and assertive actions in the treatment of this population must be the top priority of health professionals and managers, in addition to evidence-based practice, since the diverse origins of problems in health care require the use of of a range of research methodologies to generate appropriate evidence2 .

The indispensable application of the best evidence in the treatment of patients with respiratory diseases that result in an increase in the production of tracheobronchial secretions has led to the development of health technologies for the application of knowledge and skills organized in the form of devices, medicines, vaccines, procedures and systems to solve a health problem and improve quality of life2 .

In the mid-1980s, originally developed in Switzerland by the company Varioraw, *Flutter* VRP13 is a technology that uses high-frequency oral oscillation (OOAF) for bronchial clearance. Likewise, based on the results of *Flutter,* the company NCS do Brasil launched, in September 2002, a national prototype called *Shaker4* . In addition to having demonstrated its effectiveness in intrapulmonary oscillation and consequently in increasing the quantity and quality of sputum in adult patients, *Shaker* has mechanical benefits similar to *Flutter* VRP1, with a low financial cost as it is nationally produced. This is an advantage of the device's availability in Brazilian territory for clinical practice5 .

Several different devices have been developed with high frequency oscillation and PEP for bronchial hygiene, *Acapella* has demonstrated improvements in airway ventilation, lung function, quality of life and mainly in the reduction of exacerbations in individuals with COPD6 .

The objective of this study was to update knowledge about the scenario of use of OOAF devices internationally.

Methods

This is a Systematic Review of the *UpToDate* type with a research protocol published in the *International prospective register of systematic reviews* (PROSPERO) CRD42019130022 published on July 29, 2019.

Types of studies: randomized controlled trials (RCTs) that used oscillatory positive expiratory pressure devices.

Types of participants: inclusion of journal articles published between October 2009 and October 2019, without language restrictions, studies carried out

with adults and children of any ethnicity, who used OPEP devices *(Flutter, Shaker, Acapella* and *Aerobika)* as bronchial hygiene therapy with active individuals in spontaneous breathing and diagnosed with acute or chronic respiratory diseases with obstructive characteristics and hypersecretivity conditions. The exclusion criteria were: articles that did not use these devices in the treatment of hypersecretive diseases, publications in the form of letters, reviews, comments, dossiers, newsletters, abstracts of annals.

A three-step research strategy was carried out. First, a limited search, following the analysis of the text words contained in the title, abstract and the keywords used to describe the article. Second, with all keywords and index terms identified in the databases: *Scientific Electronic Library Online* (SciELO), *United States National Library of Medicine* (PubMED), *Cochrane Controlled Register of Trials*

(CENTRAL) e *Evidence Based Clinical decision (UpToDate).* Google Scholar was used in the literature search gray and unpublished studies. Third, the reference lists of all identified reports and articles were saved for further study.

Types of result measures: after the research was carried out, all identified citations were collated and loaded into a single table with titles, URL, description and details of the articles filtered for primary result with the *Microsoft Office Excel* 2013 tool *(Microsoft Corporation,* United States - USA) and the removal of duplicate articles was carried out. Continuing to read the words contained in the title, the secondary results were achieved with the Relevance Test 1 (TR1) prepared by the researchers (Appendix 1).

Article exclusions were carried out due to non-compliance with the minimum TR1 criteria, as well as the reading of summaries with filtering by Relevance Test 2 (TR2) (Appendix 1), obtaining the articles for complete reading and data extraction. The research results are presented with the recommendations of the PRISMA model (Main Items for Reporting Systematic Reviews and Meta-Analyses) (Figure 1).

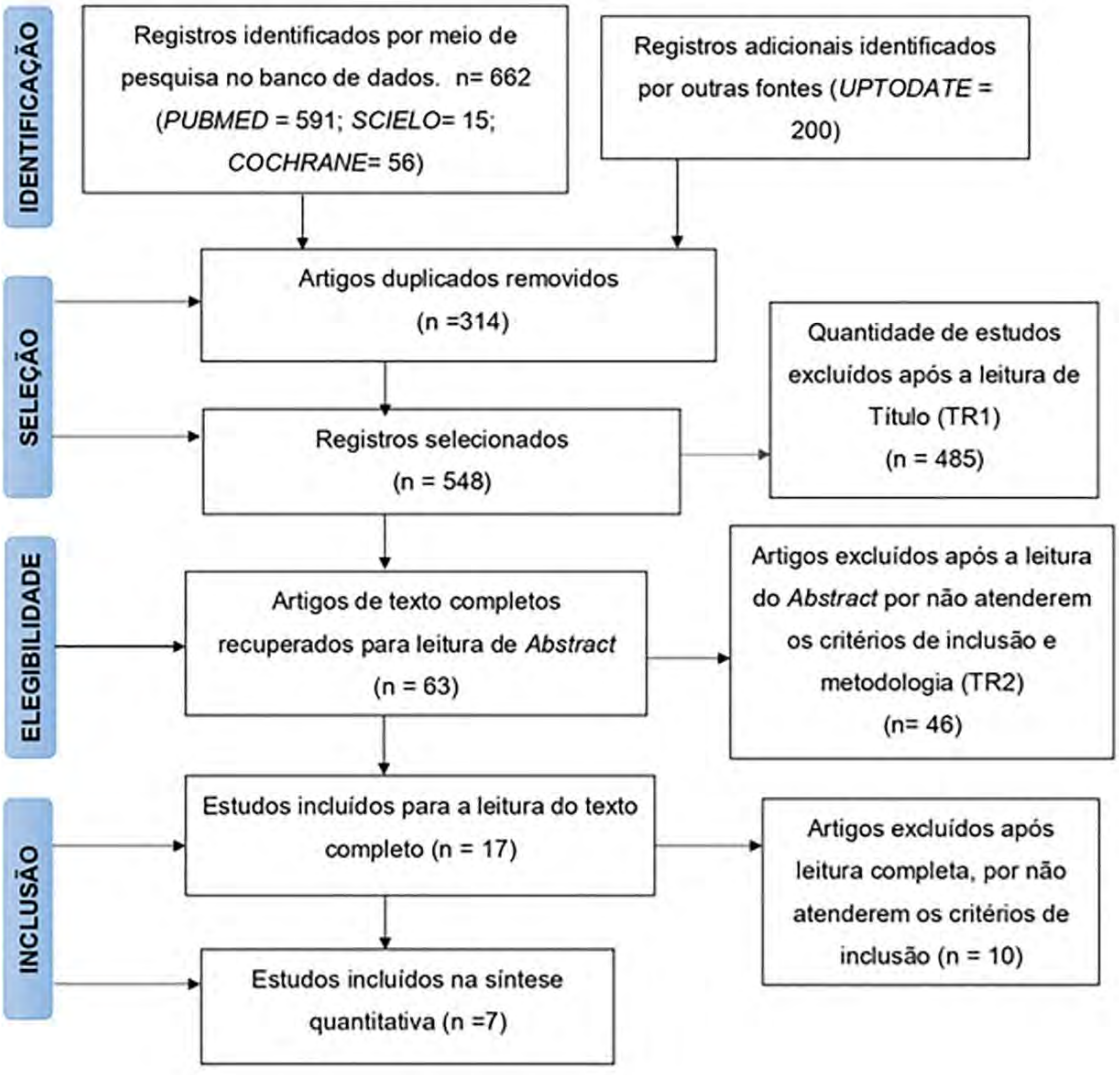


Figure 1. PRISMA research flowchart and study inclusion process. TR1: Relevance test 1; TR2: Relevance test 2.

The research was carried out by two independent reviewers, and the selected studies were critically evaluated by Yanca Carollynne Souza Moraes and Luciana Carvalho Silveira. The qualitative methodological evaluation of the articles was carried out using the standardized *Joanna Briggs Institute* – JBI (Faculty of Health and Medical Sciences, University of Adelaide, Australia) questionnaire for randomized clinical trials, consisting of 13 questions, divided into the following answers: “yes” , “no”, unclear” and “not applicable”, relating the positivity of the answer to the question applied to a higher quality score of the study. The *score* determined for inclusion in the qualitative synthesis was equal to or greater than 70%. The result is shown in Graph 1.

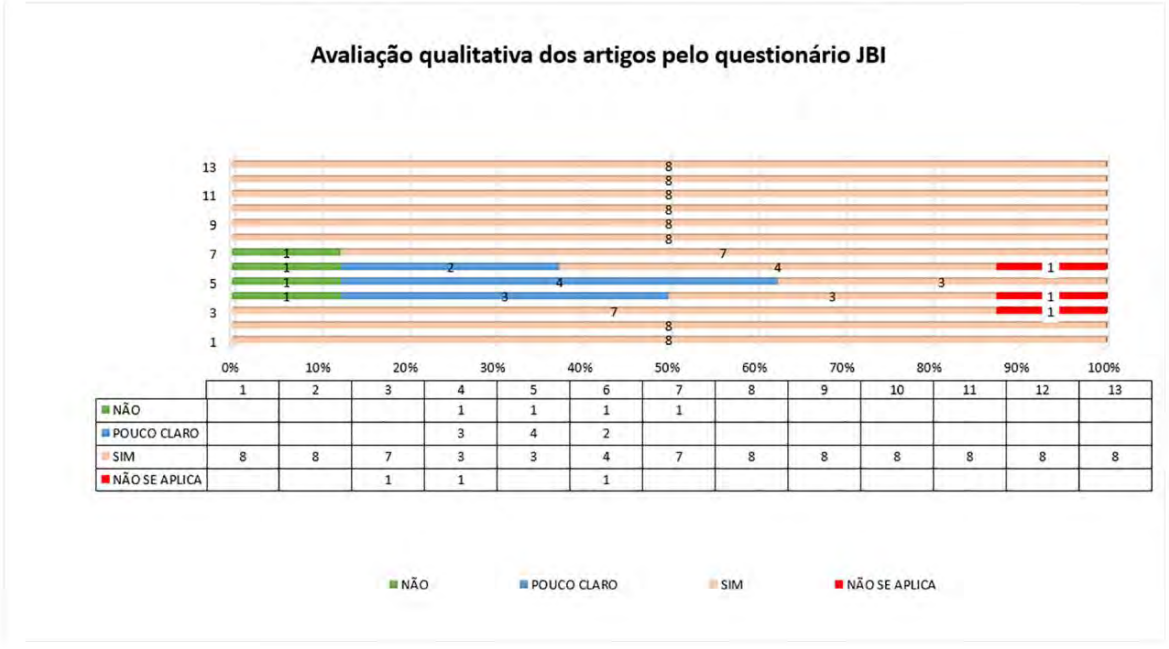
Research methodology: a Systematic Review of the *UpToDate type was carried out.* We searched the aforementioned databases, from October 2009 to October 2019. The keywords chosen in the Health Sciences Descriptors (DeCS) were: “Physiotherapy”, “Oscillatory positive expiratory pressure”, “Mucociliary clearance”, “Physical therapy modalities”, and their respective in English in the Medical Subject Headings (MeSH) are: *“Phisiotherapy”, “Oscillatory Positive Expiratory Pressure (OPEP)”, “Airway Clearance” “Physical Therapy Modalities”.* For the *UpToDate* database, the following were used: *“Expiratory positive airway pressure” and “Oscillatory positive expiratory pressure”,* because the *UpToDate* platform only allows one keyword. The search combined the uniterms with the Boolean operator “AND” and its corresponding “AND”.

Results

862 articles were found in the total search (databases), 17 articles were retrieved for reading from the full text (Figure 1). Of these, only 7 articles were selected for the qualitative synthesis and, after evaluation, all were included in the quantitative synthesis. Ten articles were excluded for the following reasons: one was a duplicate with a different title and date than the original article, showing a difference of 2 years of publication between both and the same sample group. Two articles were cross-sectional studies, 4 articles were just *Abstracts* of works published in abstracts and conference annals, in contact with the authors, the original articles were not published, constituting insufficient data for research. Two articles did not use OOAF devices in comparison to treatment between groups, and lastly, the study classification did not correspond to the methodology of a randomized clinical trial.

Table 1 shows details of the studies included, consisting entirely of randomized controlled and crossover clinical trials, carried out in different countries. Brazil appears in the vast majority with 42.8%, where the place of screening and monitoring of patients was, in 71% of cases, in outpatient clinics of university hospitals. The quantitative sample represented 176 adults, with a mean age of ± 56.31 years, of which the largest 71% were diagnosed with bronchiectasis.

In Table 2, the instruments most used in the studies were predominantly the *Flutter* device with 71% of choice. The average treatment protocol time was ± 4.5 weeks, except in Murray's study, which lasted 7 months. The time used for the devices in one service was ± 25.83 minutes. The study by Svenningsen et al. (2016)7 was not included in the evaluation of the average time as it did not provide data regarding the duration of the session in minutes.



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Graph 1. Qualitative evaluation of articles using the *Joanna Briggs Institute* JBI questionnaire.

Table 1. Characteristics of included studies.

AUTHOR	YEAR COUNTRY LOCATION OF SEARCH	KIND OF STUDY	SIZE AND SAMPLE/ AGE AVERAGE	OBJECTIVE DIAGNOSIS	
1) Tambascio *et al.*	2017 Brazil Hospital University	ERC,C,C	17 adults/ 54.8 years ± 13.7	Bronquiectasia	Evaluate the effects of *Flutter* on microinflammation in sputum microbiology and transport of secretions.
2) Svenningsen *et al.*	2016 Canada Home	ERC,C,C	27 adults/ 69 years ± 8	Productive and non-productive COPD	Assess daily use of OOAF in patients with COPD.
3) Silva *et al.*	2017 Australia Outpatient (Hospital Teaching)	ERC,C,C	40 adults/ 63 years ±16	Bronquiectasia	Compare *Flutter* devices and Lung Flute.
4) Dwyer *et al.*	2017 Australia Outpatient (Hospital Public)	ERC,C,C	24 adults/ 30 years ±8	Mild Cystic Fibrosis a grave	Assess respiratory flow, sputum properties and responses to exercise.
5) Simon *et al.*	2019 Brazil Outpatient (Hospital University)	ERC,C,C	40 adults/ 57 years ± 14	Bronchiectasis	Evaluating the effect of OOAF on secretion clearance and respiratory system impedance.
6) Figueiredo *et al.*	2010 Brazil Outpatient (Hospital University)	ERC,C,C	8 adults/ 4 years 4 7 ±5,8	Bronquiectasia	Test whether *Flutter* may improve short-term clearance in hypersecretive patients.
7) Murray *et al.*	2009 Scotland Outpatient (Hospital University)	ERC,C,C	20 adults/ 73 (72-77)	Bronquiectasia	Establish the effectiveness of respiratory physiotherapy routine with use of the device OOAF and compare individuals without physical therapy

Legend: RCT, C, C: Randomized, Controlled, Crossover Clinical Trial.

Table 2. Results of included studies.

AUTHOR	INSTRUMENTS	FREQUENCY OF INTERVENTION	RESULTS
1) Tambascio *et al.*	Flutter	10 total weeks of study 4 weeks stage 1 – *Flutter* 2 weeks break – crossover 4 weeks stage 2 – *Flutter* without sphere 30 minutes for both stages	Improvement in peak cough flow pre- and post-treatment in the *Flutter* group in relation to the control group.
2) Svenningsen *et al.*	Aerobika X Care Standards (without Aerobika)	7 total weeks of study 28 ± 5 days stage 1 – Aerobika 21 ± 5 days stage 2 – Without Aerobika 4 times a day* 10-20 puffs +2-3 coughs	Improvement of *post-Aerobika* sputum in patients with sputum-producing COPD, improvement of ventilation, FEV1 and FVC exercise capacity.
3) Silva *et al.*	*Flutter* X Fl a u t a pulmonar	3 total weeks of study 1 session in stage 1 – *Flutter* 1 week break – crossover 1 session in stage 2 – Pulmonary flute 30 min Intervention + cough and expectoration 30 minutes of rest + cough and expectoration	The average weight of expectorated sputum was greater with the *Flutter* immediately after the intervention, and after 30 minutes of intervention, the average weight of expectorated sputum was greater with the use of the pulmonary flute.
4) Dwyer *et al.*	Treadmill X *Flutter* Control (Rest)	1 total week of study Stages 1, 2 and 3 take place simultaneously for 3 days and each lasts 20 minutes 24-48 hour interval on work days intervention Step 1 – Rest and breathing control Step 2 – Exercise on the treadmill Stage 3 – *Flutter* (6x 15 puffs followed by coughing)	Peak cough flow was greater during treadmill exercise and *Flutter* compared to control (Rest), only *Flutter* produced an expiratory flow in the airways *(expiratory airflow bias).* Both treatments resulted in similar significant reductions in mechanical impedance to sputum, therefore, treadmill exercise and *Flutter*® therapy are equally effective in increasing mucus clearance mechanisms in adults with Cystic Fibrosis.
5) Simon *et al.*	*Flutter* vs Compression Thoracic x Control	3 total weeks of study 1 day for each intervention 1 week break between stages 30 min Intervention + cough and secretion collection and 30 min rest + cough and secretion collection	Only *Flutter* was effective in removing secretion and had a beneficial effect on the total and peripheral resistance of the respiratory system, while chest compression only decreased peripheral resistance in individuals with Bronchiectasis. Only *Flutter* was statistically significant for the production of expectorated secretion with higher dry weight.
6) Figueiredo *et al.*	*Flutter* X *Flutter Sham*	3 total weeks of study during 1 day for stage 1 1 week break day for stage 2 session (15 min devices + airway patency, reducing resistance 5 min cough)	There was a greater volume of sputum produced o *Flutter* do que *Flutter* Sham. O uso do *Flutter* by patients with bronchiectasis produced 1 more 25 mL of sputum daily improving after 20 min total and peripheral respiratory.
7) Murray *et al.*	*Acapella* XS em Physiotherapy Respiratory	7 months of study* 3 months physiotherapy with *Acapella* – stage 1 1 month break 3 months without respiratory physiotherapy – stage 2 2 times a day in step 1 20-30 minutes (3x 10 puffs + TEF + cough)	The 24-hour sputum volume increased significantly, as did exercise capacity with respiratory physiotherapy sessions using Acapella .

Caption: FEV1: Forced expiratory volume in the 1st second; FVC: Forced vital capacity; TEF: Forced expiration technique; *Murray: The average session in weeks was not considered; *Svenningsen: The study was not considered in the average session minutes because it did not provide this data.

Discussion

Several countries, on different continents, maintain the use of OOAF as bronchial hygiene therapy, highlighting the similarity in the choice of these devices internationally. Brazil stands out for hosting 42.8% of the selected studies, with outpatient clinics at University Hospitals (HUs) being represented in 71% of the places where the research was carried out.

HUs present great heterogeneity in terms of their installed capacity, technological incorporation and scope of service, playing a prominent role in the community where they are located. In its definition, HUs presuppose the integration of teaching, research and assistance8 . Araújo et al. (2014)8 carried out a study through semi-structured interviews with managers from 13 of the 31 general HUs of federal universities and concluded that, although the majority of HUs have already formally introduced research activity alongside teaching and assistance missions, in practice , the teaching-assistance binomial prevails as a hallmark of these institutions, a fact that corroborates the findings of our study, represented by Brazilian, Australian and Scottish HUs respectively8 .

Svenningsen et al. (2016)7 opted for a home treatment protocol, a reason that can be justified by climate influence, since the country's low temperatures throughout the year9 do not allow adherence to physiotherapeutic treatment in clinics or outpatient clinics.
Therefore, home treatment with OOAF devices is more viable and accessible7 .

Guimarães et al. (2011)10, with a randomized, crossover study, presented results with the use of OOAF in adults aged between 55.9 ±18.1 years, confirming the data found in our study with a total sample of adults with a mean age of ± 56.31. It is considered that the effectiveness of OOAF is guaranteed by positioning the devices at different angles. Positive angulations between 30° and 40° with greater airflows resulted in a higher frequency of oscillation, obtaining greater optimization of results11,12. The preference for the adult population is explained by the fact that they have a better understanding of the use of OOAF, avoiding adverse effects during treatment10.

Bronchiectasis, as it is an irreversible enlargement of portions of the respiratory ducts resulting from damage to the airway wall, involves excessive daily mucus production, which is based on the findings of 71% of the profile of patients found in studies. The Ministry of Health in 2014 shows a mortality rate of 0.2/100,000 inhabitants caused by the disease, which has an incidence and prevalence that differs according to age, geographic and ethnic variation13. Simas et al. (2018)13 found in their study that the outpatient clinics of university hospitals are the places with the highest concentration of chronic respiratory pathologies such as bronchiectasis, and that despite being a recurrent disease in several studies, the quality of life in this population is still scarce and little debated13.

There are multiple causes that interfere with the choice of an OOAF, the first being cost, the population's access to the devices for marketing reasons, as well as their recognition in a scientific context of evidence14. The popularity of the *Flutter device,* verified in 71% of studies, is justified by its dominance in the European market and neighboring countries. Three Brazilian studies contradict what was expected, since *Shaker,* being a national product with low final cost, was not used in Brazilian research15.

Oliveira et al. (2018)5 highlighted the effectiveness of *Shaker* through an experimental study with 20 adult individuals between 30 and 85 years old diagnosed with nosocomial pneumonia. It is noteworthy that the *Shaker* reaches well-defined resonant frequency peaks and relatively higher potentials in its mechanical performance, therefore the unblocking result achieves a greater amount of mucus expectoration. The study also highlights the advantage of the financial cost being five times lower, making it more accessible to the population compared to *Flutter* VRP15 .

It is noted that evidence-based practice seems to be guided by a strong brand, enabling publications at an international level through its use, since national prototypes with low cost and easy access are not being used. In 2018, a prospective, multicenter study by Matilde et al. (2018)14 collected data on the main bronchial hygiene maneuvers used in the clinical practice of physiotherapists in 5 national hospitals, and as a result the OOAF were not even mentioned as a treatment possibility, thus corroborating the results of this review, which finds a gap between the practice clinical and levels of evidence14.

Murray et al. (2009)16, in their study carried out in a HU in Scotland, chose the OOAF *Acapella,* notably for its strong health educational campaigns about the device in hospital outpatient clinics and charity institutions in the United Kingdom, elucidating the importance of choosing the instrumental resource national level and great adherence to physiotherapeutic treatment.

Conclusion

The use of OOAF is observed at an international level and its applicability is determined by local marketing issues. Flutter is the device of first choice and the outpatient clinics of university hospitals *are* the main location for studies, and adults with bronchiectasis are the sample that characterizes them. The great production and retention of mucus associated with the level of collaboration during therapy in this population promotes better clinical outcomes.

Educational campaigns about OOAF must be carried out to raise awareness among the target population of the importance of using the devices, as well as among health professionals, especially Brazilian physiotherapists, in order to revive their use in clinical practice, since the prototype Nacional *Shaker* is low-cost, accessible and produces effects equal to and even superior to *Flutter.*

The improvement in expectoration, peak cough flow and reduction in airway resistance occurs after an average of 4 weeks of treatment with sessions lasting approximately 25 minutes. The efficacy and effectiveness of OOAF devices are indisputable, several studies with different methodologies have been carried out and unanimously all conclude the satisfactory effects of the devices.

Author Contribution

The authors' contributions are structured according to the taxonomy (CRediT). Conceptualization: LCS and YCSM; methodology: LCS and YCSM; software: YCSM and LCS; validation: YCSM, ECA, VHSU and LCS; formal analysis: YCSM, LCS; resources: YCSM and LCS; data curation: YCSM, ECA, VHSU and LCS; writing and preparing the original draft: YCSM and LCS; written review and editing: YCSM, ECA, VHSU and LCS; visualization: ECA, VHSU and LCS; supervision: LCS; project administration: LCS All authors agree to the final version of the manuscript.

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Annex 1. Relevance Tests (operational protocols) prepared by the researchers.

RELEVANCE TEST I: (TITLES)

I- STAGE 1: Combinations of descriptors*;
II- STAGE 2: Search in databases: PubMed; SciELO, Cochrane CENTRAL and UpToDate.
III- STAGE 3: The words in the text contained in the titles must contain at least 1 of the descriptors chosen to describe the article.

RELEVANCE TEST II: *(ABSTRACT-ABSTRACT)*

Studies must correspond to at least all four stages of this second part of the research, these being the main criteria of the study.

I- STAGE 1: Studies are carried out with human beings: Adults or children of any ethnicity; II-
STAGE 2: Studies that used OOAF high-frequency oral oscillator devices; III- STAGE 3: Individuals
diagnosed with acute or chronic respiratory diseases with obstructive characteristics and hypersecretivity; IV- STAGE 4: Clinical trials (CE).