





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

*O uso de dispositivos de pressão expiratória positiva oscilatória: uma revisão sistemática*

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## 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  $\pm$  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); Physiotherapy; Physical therapy modalities.

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### Supporting sources:

There were no supporting sources.

### Conflict of Interests:

No conflict of interest.

Received on: 1 November 2023

Approved on: 11 December 2023

Publication Date: 10 July 2024.

DOI: 10.5935/2238-3182.2024e34202-en

## RESUMO

**Introdução:** A indispensável aplicação da melhor evidência no tratamento de pacientes com doenças respiratórias que cursam com aumento na quantidade de produção de secreções traqueobrônquicas. **Objetivo:** Atualizar o conhecimento sobre o cenário do uso dos dispositivos de pressão expiratória positiva oscilatória em âmbito internacional. **Métodos:** Revisão Sistemática com ensaios clínicos randomizados, controlados, cruzados, obtidos nos bancos de dados PubMed, SciELO, Cochrane e UpToDate. Foram encontrados 862 artigos, sendo 7 incluídos na análise qualitativa e quantitativa. **Resultados:** Em predomínio, o dispositivo *Flutter* foi utilizado, em ambulatórios de hospitais universitários, com adultos diagnosticados com bronquiectasia com idade média de 56,31 anos. O tratamento foi de  $\pm 4,5$  semanas com duração de aproximadamente 25 minutos. **Conclusão:** A eficácia e a efetividade dos dispositivos OOAF são indiscutíveis. Vários estudos com distintas metodologias foram realizados e, em unanimidade, todos concluem os efeitos satisfatórios dos dispositivos.

**Palavras-chave:** Fisioterapia; Pressão expiratória positiva oscilatória; Depuração mucociliar; Modalidades de fisioterapia.

## INTRODUCTION

Respiratory diseases impose an immense burden on global health, and four respiratory diseases are among the most common causes of death worldwide, they are: chronic obstructive pulmonary disease (COPD), community-acquired pneumonia (CAP), nosocomial pneumonia and bronchiectasis<sup>1</sup>.

Given this scenario, the importance of preventive and assertive actions in the treatment of this population must be the top of the priorities of health professionals and managers. In addition to evidence-based practice, since the diverse origins of health care problems require the use of a range of research methodologies to generate appropriate evidence<sup>2</sup>.

The indispensable application of the best evidence in the treatment of patients with respiratory diseases that are accompanied by an increase in the amount of 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, medications, vaccines, procedures and systems to solve a health problem and improve the quality of life<sup>2</sup>.

In the mid-1980s, originally developed in Switzerland by the company Varioraw, the Flutter VRP<sup>3</sup>, is a technology that uses high frequency oral oscillation (HFOO) for bronchial clearance. Likewise, based on the results of the Flutter, the company NCS do Brazil launched in September 2002 a national prototype called Shaker<sup>4</sup>. 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. The main advantage of the availability of the device in Brazilian territory for clinical practice<sup>5</sup>.

Several and different devices have been developed with high frequency oscillation and PEP for bronchial hygiene, Acapella has shown improvements in airway ventilation, lung function, quality of life, and especially in reducing exacerbations in individuals with COPD<sup>6</sup>.

The objective of this study was to update knowledge about the scenario of the use of HFOO devices at the international level.

## METHODS

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

Types of studies: randomized clinical trials (RCTs) using positive oscillatory 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, using OPEP devices (Flutter,

Shaker, Acapella and Aerobika) as bronchial hygiene therapy with individuals active in spontaneous breathing and diagnosed with acute or chronic respiratory diseases with obstructive characteristics and hypersecretivity. 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, summaries of proceedings.

A three-step research strategy was carried out. First, a limited search, following the analysis of the words of the text contained in the title, abstract and the keywords used to describe the article. Second, with all key words and index terms identified in the databases: ScientificElectronic Library online (SciElo), United States National Library of Medicine (PubMed), Cochrane Controlled Register of Trials (CENTRAL) and Evidence Based Clinical decision (UpToDate). Google Scholar was used to search for gray

literature and unpublished studies. Third, reference lists of all identified reports and articles have been saved for further study.

Types of outcome measures: After the research was carried out, all identified citations were linked and loaded into a single table with titles, URL, description and details of the articles filtered using the Microsoft Office Excel 2013 tool. The duplicate articles were removed, continuing reading words contained in the title, with a Relevance Test 1 (RT1) prepared by the researchers (Annex 1). Exclusions of articles which did not fulfill the minimum criteria of RT1, as well as reading abstracts with filtering by the Relevance Test 2 (RT2) (Annex 1), obtaining the articles for complete reading and data extraction. The survey results are presented with the recommendations of the PRISMA model (Main Items for Reporting Systematic Reviews and Meta-analyses), figure 1.

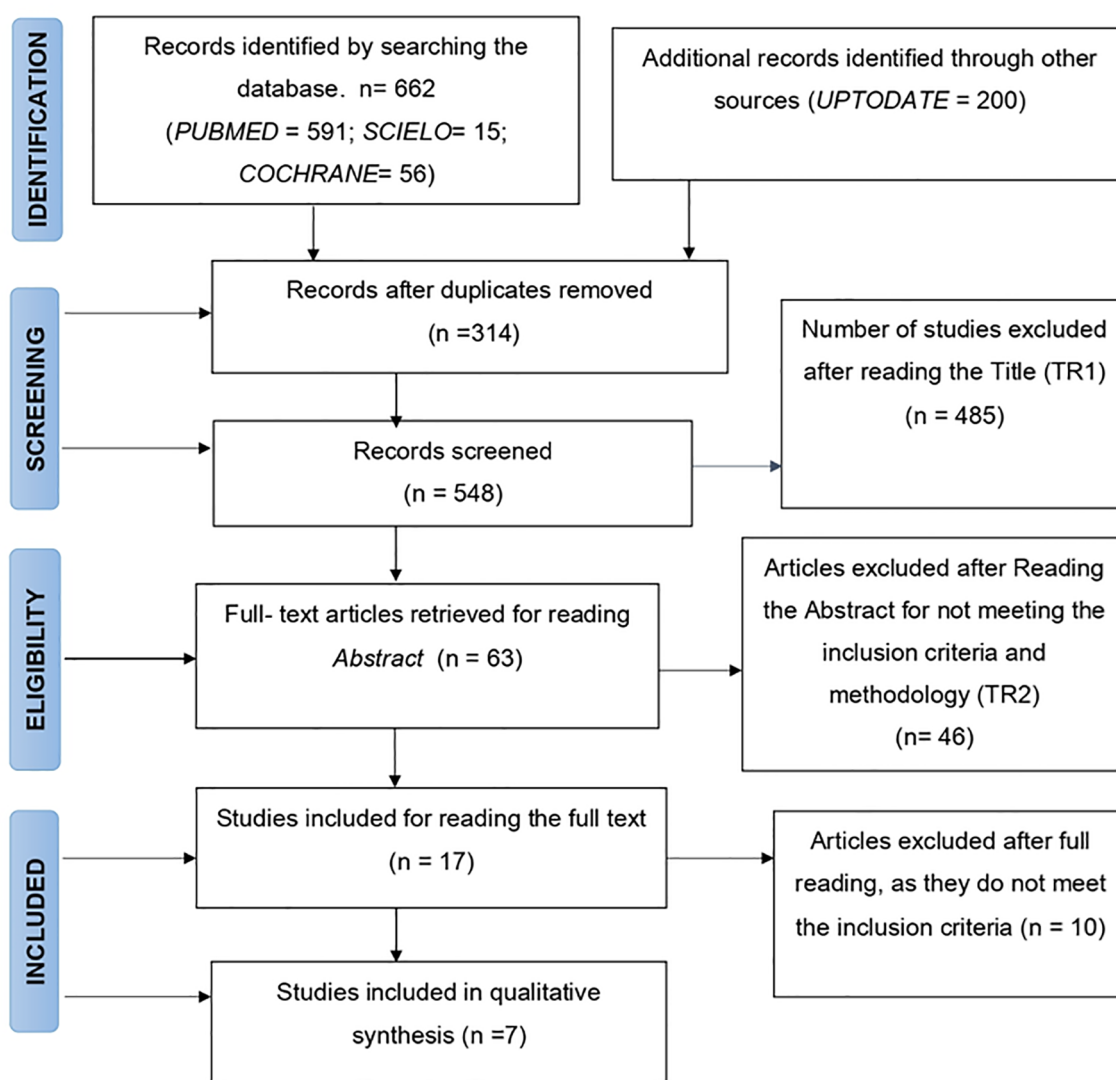


Figure 1. PRISMA Flow-chart of research and inclusion process of studies. Subtitle: RT1: Relevance test 1; RT2: Relevance test 2.

The research was carried out by two independent reviewers, and the selected studies were critically evaluated by (Yanca Carollynne Souza Moraes e Luciana Carvalho Silveira). The qualitative methodological assessment of the articles was carried out using the standardized Joanna Briggs Institute (JBI) questionnaire for randomized clinical trials, consisting of 13 questions, divided between 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 70% or greater. The result is shown in Graph 1.

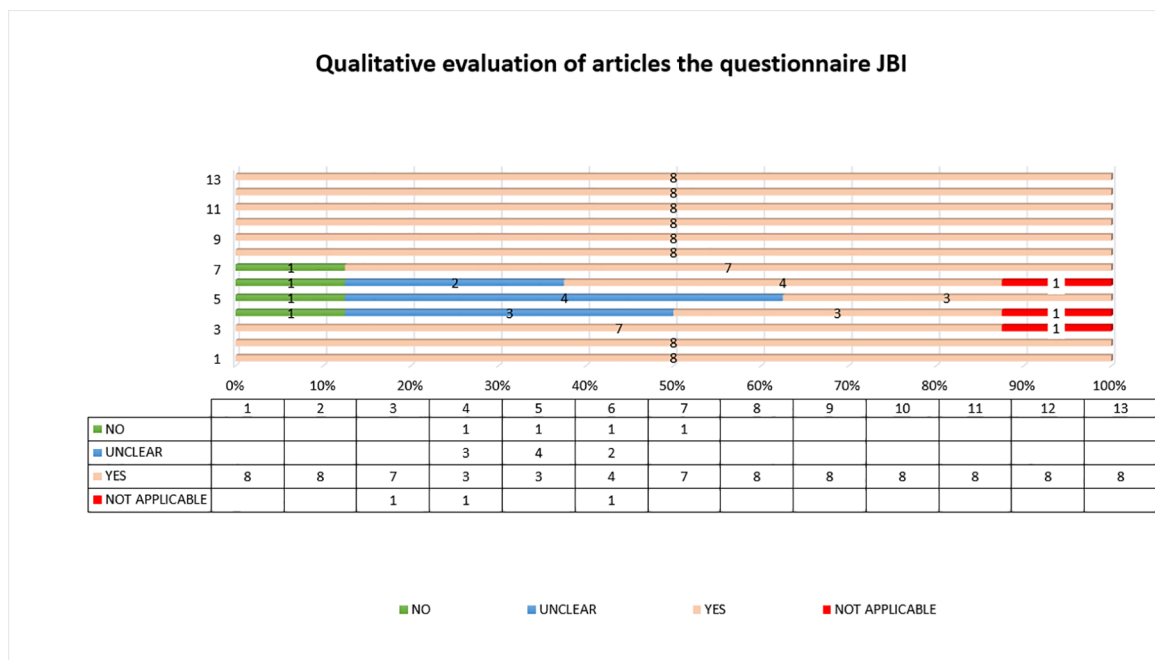
Search methodology: A systematic review of the type UpToDate was carried out. We searched the databases mentioned, in the period between October 2009 and October 2019. The keywords chosen in the Health Sciences Descriptors (DeCS) were: “Fisioterapia”, “Pressão Expiratória Positiva Oscilatória”, “Depuração Mucociliar”, “Modalidades de Fisioterapia”, and their respective equivalents in English in the Medical Subject Headings (MeSH) are: “Physiotherapy”, “Oscillatory Positive Expiratory Pressure (OPEP)”, “Airway Clearance” “Physical Therapy Modalities”. For the UpToDate database, “Expiratory positive airway pressure” and “Oscillatory positive expiratory pressure” were used, because the UpToDate platform allows only one keyword. The search combined the terms with the Boolean operator “E” and its corresponding “AND”.

(Figure 1). Of these, only 7 articles were selected for the qualitative synthesis and after the evaluation all were included in the quantitative synthesis. Ten articles were excluded for the following reasons: one was duplicated with a different title and date from the original article, with a difference of 2 years of publication between both and the same sample group. Two articles were cross-sectional studies, 4 articles were only Abstracts of works published in abstracts and conference proceedings, in contact with the authors the original articles were not published, constituting insufficient data for the research. Two articles did not use HFOO devices compared to treatment between groups, and finally, the study classification did not match the methodology of a randomized clinical trial.

Table 1 shows details of the included studies, constituting in its entirety randomized controlled and crossover clinical trials, carried out in different countries. The vast majority of Brazil appears with 42.8%, where the place of screening and monitoring of patients was in 71% of outpatient clinics in university hospitals. The quantitative sample represented by 176 adults, with an average age of ± 56.31 years, of which 71% in greater number with a diagnosis of bronchiectasis. In Table 2, the instruments most used in the studies were predominantly the Flutter device with 71% choice. The average treatment protocol time was ± 4.5 weeks, except for the Murray study that lasted for 7 months. The time taken to use the devices in an appointment was ± 25.83 minutes, the study by Svenningsen et al. (2016)<sup>7</sup> did not enter the average time evaluation for not providing data regarding the duration of the session in minutes.

## RESULTS

862 articles were found in the total search (database), 17 articles were retrieved for reading the full text



Graphic 1. Qualitative evaluation of articles the questionnaire Joanna Briggs Institute JBI.

**Table 1.** Characteristics of included studies.

AUTHOR	YEAR	COUNTRY	RESEARCH LOCATION	KIND OF STUDY	SAMPLE SIZE/ MIDDLE AGES	DIAGNOSIS	OBJECTIVE
1) Tambascio <i>et al.</i>	2017	Brazil	Universitary Hospital	RCT,C,C	17 adults/ 54,8 years ± 13,7	Bronchiectasis	Evaluate the effects of Flutter on micro sputum inflammation, microbiology and secretion transport.
2) Svenningsen <i>et al.</i>	2016	Canada	Home	RCT,C,C	27 adults/ 69 years ± 8	Productive COPD and not productive	Assess the daily use of HFOO in patients with COPD.
3) Silva <i>et al.</i>	2017	Australia	Ambulatory (teaching hospital)	RCT,C,C	40 adults/ 63 years ±16	Bronchiectasis	Compare Flutter and Pulmonary Flute devices.
4) Dwyer <i>et al.</i>	2017	Australia	Ambulatory (teaching hospital)	RCT,C,C	24 adults/ 30 years ±8	Cystic Fibrosis mild to severe	Assess respiratory flow, sputum properties and responses to exercise.
5) Simoni <i>et al.</i>	2019	Brazil	Ambulatory (teaching hospital)	RCT,C,C	40 adults/ 57 years ± 14	Bronchiectasis	To evaluate the effect of HFOO in The clearance of secretion and impedance of the respiratory system.
6) Figueiredo <i>et al.</i>	2010	Brazil	Ambulatory (teaching hospital)	RCT,C,C	8 adults/ 7,4 years ±5,8	Bronchiectasis	Test whether <i>Flutter</i> can improve clearance in the short term in hypersecretive patients.
7) Murray <i>et al.</i>	2009	Scotland	Ambulatory (teaching hospital)	RCT,C,C	20 adults/73 (72-77)	Bronchiectasis	Establish the effectiveness of routine respiratory physiotherapy using the HFOO device and compare individuals without physical therapy.

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

**Table 2.** Characteristics of included studies.

AUTHOR	INSTRUMENTS	INTERVENTION FREQUENCY	RESULTS
1) Tambascio <i>et al.</i>	Flutter X Flutter Without metallic sphere	10 total study weeks 4 weeks stage 1 – Flutter 2 weeks apart – crossover 4 weeks stage 2 – Flutter without sphere 30 minutes for both steps	Improvement of peak cough flow in the pre- and post- treatment in the Flgroup <i>Flutter</i> in relation to the control group.
2) Svenningsen <i>et al.</i>	Aerobika X care (without Aerobika)	7 total study weeks 28 ± 5 days stage 1 – Aerobika 21 ± 5 days stage 2 – Sem Aerobika 4 times a day* 10-20 blowing +2-3 coughs	Improved sputum after <i>Aerobika</i> in patients with sputum-producing COPD, improved ventilation, exercise capacity of FEV1 and FVC.
3) Silva <i>et al.</i>	<i>Flutter X Lung Flute</i>	3 total study weeks 1 session in step 1 – Flutter 1 break week – crossing 1 session in step 2 – pulmonary flutte 30 min of Intervention + cough and sputum 30 min of rest + cough and sputum	The mean sputum expectorated weight was greater with the Flutter soon after the intervention, and after 30 minutes of intervention the mean sputum expectorated weight was greater with the use of the pulmonary flute
4) Dwyer <i>et al.</i>	Running X Flutter X Control (Rest)	1 total study weeks Step 1, 2 and 3 happen simultaneously for 3 days and each one lasts 20 minutes 24-48 hour interval on intervention days Step 1 – Rest and beathing control Step 2 – Exercise on the treadmill Step 3 – Flutter (6x 15 blowing followed by cough)	Peak cough flow was higher during exercise on the treadmill and <i>Flutter</i> compared to the control (Rest), only the Flutter produced a flow expiratory airflow bias. Both treatments resulted in significantly similar reductions in sputum mechanical impedance, therefore, treadmill exercise and <i>Flutter</i> <sup>®</sup> therapy are equally effective in increasing mucus removal mechanisms in adults with Cystic Fibrosis.
5) Simoni <i>et al.</i>	<i>Flutter X Chest compression x Control</i>	3 total study weeks 1 day for each intervention 1 week between steps 30 min Intervention + cough and secretion collection and 30 min rest + cough and secretion collection	Only <i>Flutter</i> was effective in removing secretion and had a beneficial effect on the total and peripheral resistance on the respiratory system, while chest compression decreased only the peripheral resistance in individuals with bronchiectasis. Only the <i>Flutter</i> was statistically significant for the production of expectorated secretion with higher dry weight.
6) Figueiredo <i>et al.</i>	<i>Flutter X Flutter Sham</i>	3 total study weeks 1 day for the step 1 1 break week 1 day for the step 2 20 min of session (15 min gadgets + 5 min cough)	There was a greater volume of sputum produced during the <i>Flutter</i> than <i>Flutter Sham</i> . The use of <i>Flutter</i> by patients with bronchiectasis produced more than 25 mL of sputum daily, improving airway patency, reducing total and peripheral respiratory resistance.
7) Murray <i>et al.</i>	<i>Acapella X Without Respiratory physiotherapy</i>	7 months of study* 3 months physiotherapy with <i>Acapella</i> – stage 1 1 interval month 3 months without respiratory physiotherapy – stage 2 2 times a day in the step 1 20-30 minutes (3x 10 blowing + TEF + cough)	The 24-hour sputum volume increased significantly as did the exercise capacity with respiratory physiotherapy sessions using <i>Acapella</i> .

Legend: FEV1: Forced expiratory volume in 1 second; FVC: Forced vital capacity; FET: Forced expiration technique; \*Murray: The average session in weeks was not considered; \*Svenningsen: The study was not considered in the average session minutes for not providing this data.



## DISCUSSION

Several countries on different continents continue to use HFOO as a 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 university hospital outpatient clinics represented in 71% of the places where the research was carried out.

University hospitals (UHs) are highly heterogeneous in terms of their installed capacity, technological incorporation and comprehensive service, playing a prominent role in the community where they operate. In its definition, UHs presuppose the integration of teaching, research and assistance<sup>8</sup>. Araújo et al. (2014)<sup>8</sup> carries out a study through semi-structured interviews with managers of 13 of the 31 general UHs from federal universities and concludes that, although the majority of UHs have already formally introduced the research activity with the teaching and assistance missions, in the 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 UHs respectively<sup>8</sup>.

Svenningsen et al. (2016)<sup>7</sup> opted for a home treatment protocol, a reason that can be justified by the climatic influence, since the country's low temperatures throughout the year<sup>9</sup> do not allow adherence to physical therapy treatment in clinics or outpatient clinics. Home treatment with HFOO devices is viable and accessible<sup>8</sup>.

Guimarães et al. (2011)<sup>10</sup>, with a randomized crossover study, presents results with the use of HFOO in adults aged  $55.9 \pm 18.1$  years, confirming the data found in our study with a total sample of adults with mean age of  $\pm 56.31$ . It is considered that the effectiveness of HFOO is guaranteed by the positioning of devices at different angles. Positive angulations between  $30^\circ$  to  $40^\circ$  with higher air flows resulted in a higher frequency of oscillation, obtaining greater optimization of results<sup>11,12</sup>. The predilection for the adult population is explained by the fact of a better understanding of the use of HFOO, avoiding adverse effects during treatment<sup>10</sup>.

As bronchiectasis is an irreversible enlargement of portions of the respiratory ducts resulting from damage to the airway wall, it leads to excessive daily production of mucus, based on the findings of 71% of the profile of patients found in the studies. In 2014, the Ministry of Health shows a mortality rate of 0.2/100,000 inhabitants caused by the disease, which has a different incidence and prevalence in age, geographic and ethnic variation<sup>13</sup>. Simas et al. (2018)<sup>13</sup> found in their study that outpatient clinics in 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 are still scarce and little debated.

There are multiple causes that interfere with the choice of an HFOO, with cost coming first, the population's access to devices for marketing reasons, as well as their recognition

in a scientific context of evidence<sup>14</sup>. The popularity of the Flutter device, verified in 71% of the studies, is justified by its dominance in the European market and neighboring countries. Three Brazilian studies contradict what was expected, since Shaker, a national product, with a low final cost, was not used in Brazilian research<sup>15</sup>.

Oliveira et al. (2018)<sup>5</sup> highlighted the effectiveness of the Shaker through an experimental study by selecting 20 adult individuals between 30 and 85 years old with hospital-acquired pneumonia, standing out with well-defined resonant frequency peaks and relatively greater powers in their mechanical performance, consequently, as a clearing result, a greater quantity of expectoration. The study also highlights the advantage of five times lower cost, making it more accessible to the population compared to Flutter VRP<sup>15</sup>.

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

Murray et al. (2009)<sup>16</sup> in his study carried out in a UH in Scotland, elected the HFOO Acapella, notoriously for the strong educational health campaigns about the device in outpatient hospitals and charities in the United Kingdom, elucidating the importance of choosing the national instrumental resource and great adherence to physiotherapeutic treatment.

## CONCLUSION

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

Educational campaigns about HFOO should be carried out to raise awareness among the target population of the importance of using the devices, as well as for health professionals, especially Brazilian physiotherapists, in order to rescue the use in clinical practice, since the prototype national Shaker is low cost, accessible and produces effects equal to and even superior to Flutter.

The improvement in sputum, peak cough flow and decrease in airway resistance occurs on average for 4 weeks of treatment with sessions of approximately 25 minutes. The efficacy and effectiveness of the HFOO devices are indisputable, several studies with different methodologies

have been carried out and unanimously all concluded the satisfactory effects of the devices.

## AUTHORS' CONTRIBUTIONS

We describe contributions to the papers using the taxonomy. Conceptualization: L.C.S. and Y.C.S.M.; methodology: L.C.S. and Y.C.S.M.; software: Y.C.S.M and L.C.S.; validation: Y.C.S.M, E.C.A., V.H.S.U. and L.C.S.; formal analysis: Y.C.S.M., L.C.S.; resources: Y.C.S.M. and L.C.S.; data curation: Y.C.S.M., E.C.A., V.H.S.U. and L.C.S.; writing and preparation of the original draft: Y.C.S.M. and L.C.S.; written review and editing: Y.C.S.M., E.C.A., V.H.S.U. and L.C.S.; visualization: E.C.A., V.H.S.U. and L.C.S.; supervision: L.C.S.; project administration: L.C.S. 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 HFOO 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 (CT).