

ADVANCED HIGH-FREQUENCY CHEST WALL OSCILLATION DEVICES FOR OPTIMAL AIRWAY CLEARANCE: A COMPREHENSIVE STUDY ON THERAPEUTIC EFFICACY AND TECHNOLOGICAL INNOVATIONS.

Engineering – Health

Admilson Marin¹, Victória Cônsoli Chiaradia¹, Mirela Dobre², Andrei Brateanu³, Luciana Aparecida Campos¹, Ovidiu Constantin Baltatu, Dr¹ (advisor)

¹ Center of Innovation, Technology, and Education (CITE) at Anhembi Morumbi University, Anima Institute, Sao Jose dos Campos Technology Park, Sao Jose dos Campos, Brazil

² Division of Nephrology and Hypertension, University Hospitals, Cleveland, OH, United States.

³ Medicine Institute, Cleveland Clinic, Cleveland, OH, United States.

Introducion

In addition to postural drainage, manual chest wall physiotherapy (CWPT), and Positive Expiratory Pressure (PEP) systems, mechanical devices have been increasingly utilized to facilitate secretion mobilization and elimination (CHENG et al., 2022). Such devices work by delivering high-frequency vibrations to the chest wall and include High-Frequency Chest Wall Oscillation (HFCWO), High-Frequency Chest Wall Compression (HFCWC), or High-Frequency Chest Compression (HFCC) systems (ALLAM; BADAWY, 2021).

Objectives

This study comprehensively assessed recent systematic reviews of HFCWO devices to determine their clinical application in patients with pulmonary conditions. It also aimed to (1) summarize the evidence on efficacy and safety, (2) identify trends in scientific publications and patents, and (3) list regulatory requirements across geographic regions.

Methods:

This study utilized an integrated approach, combining bibliographic and bibliometric research and using AI tools. For bibliographic research, databases were systematically searched following guidelines, and articles were screened and synthesized. Bibliometric analysis was conducted using the Dimensions platform. AI platforms like Nested Knowledge, SciSpace, Elicit, and Dimensions facilitated data extraction. Advanced thought-based prompt engineering techniques, Chain-of-Thoughts (CoT) and Tree of Thoughts (ToT), enhanced language model capabilities for complex tasks. This approach provided a comprehensive understanding of HFCWO devices

Results

The evidence for the use of HFCWO devices is mixed. Some studies have shown that HFCWO devices can be effective in reducing hospitalizations and improving symptoms in patients with respiratory diseases. The analysis of the selected patents reveals a clear trend of innovation in the field of HFCWO devices, with China emerging as a leader with 90 patent deposits, followed by the United States with 57, Brazil and Canada with 6 each. The regulations for HFCWO devices vary in different geographical regions. In the United States, HFCWO devices are classified as Class II medical devices by the FDA and must be subject to premarket notification (510(k)) before being marketed. However, in other major regions, such as Europe, Canada, Australia, and Asia, the specific regulations for HFCWO devices are unclear.

Conclusions

Accumulating research suggests that HFCWO devices are safe and effective for the treatment of respiratory diseases, but more evidence is needed. There is an increasing trend in scientific interest and innovation on HFCWO devices. The regulatory processes for HFCWO devices are similar worldwide, with nuances of reference to those, well defined, practiced in the USA, by UL and FDA and a tendency towards standardization, however, each country may have particularities.

References:

ALLAM, N. M.; BADAWY, M. M. Does High-Frequency Chest Wall Oscillation Have an Impact on Improving Pulmonary Function in Patients With Smoke Inhalation Injury? *Journal of Burn Care & Research*, v. 42, n. 2, p. 300–304, 4 Mar. 2021.

CHENG, G. et al. Effects of High-Frequency Chest Wall Oscillation Expectoration System on Pulmonary Rehabilitation and Cortisol Function in Patients with Severe AECOPD. *Disease markers*, v. 2022, p. 3380048, 22 Jul. 2022.

Funding:

The Principal Investigator expresses gratitude to ANIMA, and CITÉ for the scholarship grant, and to the other Researchers and Advisor who made the execution of this project possible.

