

HIGH-FREQUENCY CHEST WALL COMPRESSION (HFCWC)

Mrs. G. Sarojini * | Dr. Manjubala Dash **

*Ph.D. Scholar, Himalayan University, Itanagar, Arunachal Pradesh, India &

Professor, Department of Paediatric Nursing, Sacred Heart Nursing College, Madurai, Tamilnadu, India.

** Research Guide, Professor & HOD, Department of OBG Nursing, Mother Theresa Post Graduate & Research Institute of Health Sciences, Puducherry, India.

DOI: <http://doi.org/10.47211/idcij.2021.v08i01.004>

ABSTRACT:

In healthy individuals, clearance of secretions from the respiratory tract is accomplished primarily through ciliary action. In young children the number of alveoli within the respiratory tract is also lesser and shorter and organisms may move quickly down the respiratory tract triggering more extensive involvement. Postural drainage and percussion are usually taught to family members so that the therapy may be continued at home when needed in cases of chronic disease. Since this highly labour-intensive activity requires the daily intervention of a trained caregiver, it may lead to poor compliance with the recommended treatment plan. The air-pulse generator rapidly inflates and deflates the vest, compressing and releasing the chest wall up to 20 times per second. The vibratory forces of these devices are thought to lower mucus viscosity. High-frequency airway clearance (HFCWC) assist devices generate either positive or negative trans-respiratory pressure excursions. The typical treatment lasts 20-30 minutes, and consists of short periods of compression at different frequencies, separated by coughing. The use of HFCWO compared to CPT also produced a significant improvement in blood inflammation parameter.

Key Words: respiratory tract, High-frequency airway clearance (HFCWC), short periods of compression.

ABOUT AUTHORS:



Author Mrs. G. Sarojini, Ph.D. Scholar, Himalayan University, Itanagar, Arunachal Pradesh, India & Professor, Department of Paediatric Nursing, Sacred Heart Nursing College, Madurai, Tamilnadu, India. She is active researcher and has attended various Seminars and conferences.



Author Dr. Manjubala Dash is Research Guide, Professor & HOD, Department of OBG Nursing, Mother Theresa Post Graduate & Research Institute of Health Sciences, Puducherry, India. She has published various research articles in National and International Journals.

INTRODUCTION

The healthy development of children is crucial to the future well-being of any society because they are still developing. Children are especially more vulnerable to diseases, inadequate health care, nutrition, than adults. The effects of disease, malnutrition and poverty threaten the future of children and therefore the future of the societies in which they live.. (India's Demographic profile, 2020)

ANATOMICAL DIFFERENCE IN CHILDREN

In healthy individuals, clearance of secretions from the respiratory tract is accomplished primarily through ciliary action. In Children the number of alveoli within the respiratory tract is also lesser and shorter in the young child and organisms may move quickly down the respiratory tract triggering more extensive involvement.

However, a number of conditions, including asthma, Cerebral palsy, Pulmonary infections, Bronchiectasis. Cystic fibrosis (CF), mucociliary disorders, neuromuscular disease and can result in inadequate airway clearance, either because of increased volume of secretions or increased viscosity of secretions. These secretions accumulate in the bronchial tree, occluding small passages and interfering with adequate gas exchange in the lungs. When coughing alone cannot adequately clear secretions, other therapies are used.

Conventional chest physical therapy (CPT) has been shown to result in improved respiratory function and has traditionally been accomplished through the use of percussion and postural drainage. Postural drainage and percussion are usually taught to family members so that the therapy may be continued at home when needed in chronic disease. This highly labour-intensive activity requires the daily intervention of a trained caregiver which may lead to poor compliance with the recommended treatment plan. To improve compliance and allow patients to independently manage their disease, high-frequency chest wall compression (HFCWC) devices have been developed to improve mucociliary clearance and lung function.

HISTORY OF HFCWC

Warren J. Warwick, an American paediatrician, notable for co-inventing a chest wall oscillation device called the Vest Airway Clearance System, or "The Vest", a mechanical vest for clearing the lungs of children with cystic fibrosis. It is the original High Frequency Chest Wall Oscillation Device by Advanced Respiratory. In 2003, HFCWC is a mechanical form of chest PT that consists of an inflatable vest connected by tubes to a small air-pulse generator. The air-pulse generator rapidly inflates and deflates the vest, compressing and releasing the chest wall up to 20 times per second. The vibratory forces of these devices are thought to lower mucus viscosity.

Background

High-frequency chest wall compression (HFCWC) or High-frequency chest wall oscillation devices (HFCWO) devices assist members who have the inability to cough due to respiratory muscle weakness or pulmonary conditions secondary to chronic conditions listed in the indications section above. These members are especially prone to secretion-related complications during upper respiratory tract infections or general anaesthesia. These devices work by vibrating the chest wall at a higher frequency than the individual's normal respiratory rate

High-frequency chest-wall oscillation (HFCWO) and high-frequency chest-wall compression (HFCWC) are two methods used for airway clearance. Airway clearance techniques fall into two broad categories; unassisted and assisted.¹ The word assist in this context means that the respiratory device (e.g., ventilator) does work on the respiratory system. One can tell if a device is doing work in the patient by examining the Trans respiratory pressure (pressure at the airway opening relative to pressure on the body surface²). Work on the patient is indicated by an increase in Trans respiratory pressure associated with flow in the inspiratory direction or a decrease in trans respiratory pressure associated with flow in the expiratory direction.

Unassisted methods rely on the energy from passive exhalation to generate chest-wall oscillations. In contrast, active devices such as the intrapulmonary percussive ventilator, the various "vest" devices, and external high-frequency external oscillators create either a positive or negative trans respiratory pressure change to generate high-frequency, small-volume oscillations in the airways.

Intrapulmonary percussive ventilation creates positive changes in trans respiratory difference using short, rapid inspiratory flow pulses at the airway opening and relies on chest-wall elastic recoil for passive exhalation. In contrast, HFCWC generates negative changes in pressure, thereby compressing the chest externally to cause short, rapid expiratory flow pulses and relying on chest-wall elastic recoil to return the lungs to functional residual capacity. High-frequency chest-wall oscillation uses both positive and negative pressure changes using a chest cuirass. For any method, the general idea is to augment mucus movement toward the airway opening using a variety of mechanisms.

What is the technique?

HFCWO is defined by extra-thoracic oscillations generated by forces external to the respiratory system (Warwick 1991). External chest wall oscillations are applied using an inflatable vest around the torso which is either battery operated (Fig. 1) or is attached to a machine (Fig. 2) which vibrates at variable frequencies and intensities, as set by the operator, to ensure the individual's comfort and associated concordance.

This type of device is also called the Vest because the interface between machine and patient is a custom made vest through which the oscillations travel. The "Vest" is not commonly used in Australia. This relates partly to the cost, and the weight (around 8 kg).

Physiology

HFCWO uses positive and negative pressure changes to augment peripheral and tracheal mucus movement towards the airway opening (Gross & King, 1984). Air pulses are transmitted to the vest at a high frequency increasing oscillatory chest wall compressions. During inflation the pressure increases to between 5 and 20 cm H₂O causing a short burst of expiratory flow of up to 1.6L/second. The device usually operates between 2 and 25Hz.

It is thought that secretion mobilization is enhanced by the use HFCWO by increasing the air-liquid sheer forces during expiration. Another theory is that displacement of the airway walls may disengage secretions and enhance the effect of air-liquid flow. HFCWO is also thought to enhance ciliary beating and change the tenacity of bronchial secretions, making them less thick and therefore easier to expectorate (Hansen & Warwick, 1990).

Goals of HFCWO

The goals of HFCWO treatment are the same as with any other airway clearance technique—to break up mucus and help bring it to the upper airways, where it can be coughed out or removed by suction. The machine connected to the vest is an air compressor that delivers bursts of air to rapidly inflate and deflate the vest about 25 times per second. This creates gentle pressure and vibration on the chest, which does three things:

1. Breaks up mucus, making it thinner
2. Creates "mini-coughs" in the lungs, which help push the mucus out
3. Makes the cilia move faster, helping them carry the loosened mucus to the upper airways

Benefits

High-frequency airway clearance (HFCWC) assist devices generate either positive or negative trans-respiratory pressure excursions to produce high-frequency, small-volume oscillations in the airways. HFCWC can lead to changes in volume of 15-57 ml and in flow up to 1.6 L/s, which generate minimal coughing to mobilize secretions. The typical treatment lasts 20-30 minutes, and consists of short periods of compression at different frequencies, separated by coughing.

Indications: A. Cystic fibrosis or immotile cilia syndrome B. Chronic bronchiectasis which has been confirmed by radiological scan and is characterized by: i. Daily productive cough for at least 6 continuous months; or ii. More than two exacerbations in a 12 month period which required antibiotic treatment 2. Documentation indicates that the member has received optimal medical management (e.g. antibiotics, bronchodilators and other techniques to enhance mucous clearance such as use of flutter valve and/or chest physiotherapy). 3. Documentation indicates that the standard treatments noted above have either failed to help the member mobilize secretions or cannot be performed. 4. When these criteria are met, the HFCWC system will be covered for an initial rental period not to exceed three months. Coverage beyond three months requires a new prior authorization request which indicates that the member is consistently using the device. 5. A replacement HFCWC system (E0483) may be covered as an outright purchase/ rent to own when A. it is non-functional due to normal wear and tear, and B. it is no longer covered under the manufacturer's warranty, and C. it has been determined by the durable medical equipment (DME) vendor to require repairs which are not cost effective.

Contraindications:

- Unstable neck injury
- Port being accessed under vest
- Pulmonary embolism
- Lung contusion
- Current haemoptysis
- Haemodynamic instability
- Rib fractures

- Large pleural effusion or empyema.

Precautions:

- End stage disease (end expiratory volume may fall below closing capacity)
- Port under the vest (not currently accessed)
- Recent oesophageal surgery
- Distended abdomen
- Bronchospasm
- Osteoporosis
- Coagulopathy

Potential Adverse effects

1. Decreased Oxygenation (Increased ventilation drive and heart rate)
2. Bronchospasm (Wheezing and dyspnoea)
3. Pulmonary Haemorrhage (Frank Haemoptysis and dyspnoea)

Advantages:

- Treatment can be done without help.
- Does not require any skill, so every treatment will be done correctly.
- Freedom to do other things during treatment, because no special position or breathing techniques are required.
- Treats all lobes of the lung at once, so treatment time is shorter than manual CPT.

Disadvantages:

- Requires access to electricity.
- Must bring equipment with you when travelling. The compressor weighs between 10 and 30 pounds, depending on the model.

Clinical Evidence

Background High-frequency chest wall compression (HFCWC) or High-frequency chest wall oscillation devices (HFCWO) devices assist members who have the inability to cough due to respiratory muscle weakness or pulmonary conditions secondary to chronic conditions listed in the indications section above. These members are especially prone to secretion-related complications during upper respiratory tract infections or general anaesthesia. These devices work by vibrating the chest wall at a higher frequency than the individual's normal respiratory rate

Antonello Nicolin, 2013 conducted a study to find the more efficacious treatment in patients with bronchiectasis: traditional techniques of chest physiotherapy (CPT) versus high frequency oscillation of the chest wall in patients with bronchiectasis. The use of HFCWO compared to CPT also produced a significant improvement in blood inflammation parameter C-RP ($p \leq 0.019$), parameters of lung functionality associated with bronchial obstruction (FVC, FEV1) ($p \leq 0.006$ and $p \leq 0.001$).

Prescription of the technique

HFCWO allows the patient to receive treatment to a large portion of their lung in a variety of modified postural drainage positions. It can be also done in sitting, thereby eliminating issues associated with reflux and certain modified positions.

HFCWO can be administered by a physiotherapist, appropriately trained carer, or the patient themselves, allowing the potential for independent treatment.

Can combine HFCWO therapy with a mucolytic inhalation and intersperse every 5 minutes with periods of either PEP therapy and huffing and coughing to clear the mucus.

A program can be set up whereby the frequency and pressure is adjusted approximately every 5 minutes or as indicated to assist with sputum movement from the peripheral to the more central airways.

REFERENCES:

1. Antonello Nicolin,(2013) Effectiveness of treatment with high-frequency chestwall doi: 10.1186/1471-2466-13-21.pubmed.ncbi.nlm.nih.gov ›
2. Audrius V Plioplys' Shelley Lewis, & Irene Kasnicka (2002) Pulmonary vest therapy in paediatric long term care DOI: 10.1097/01.JAM.0000028225.84012.3B.
3. Nicolini A, Grecchi B, Ferrari-Bravo M, et al. (2018) Safety and effectiveness of the high-frequency chest wall oscillation vs. intrapulmonary percussive ventilation in patients with severe COPD. *Int J Chron Obstruct Pulmon Dis.* 16;13:617-625
4. Reychler, G., Debier, E., Contal, O, & Audag, N. (2018). Intrapulmonary percussive ventilation as an airway clearance technique in subjects with chronic obstructive airway diseases. *Respiratory Care*, 63 (5), 620-631.
5. www.uhcprovider.com › policies › medicaid-comm-plan