Adaptive High Frequency Chest Wall Oscillation (HFCWO) Therapy for Maximum Patient Adherence: A Patient-Centered Approach

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Abstract

For over 20 years, the standard prescription for high frequency chest wall oscillation (HFCWO) has been 30 minutes twice per day. The history of this choice was based on the similarity to manual chest physiotherapy and may not have any relevance to what patients actually need. The time commitment for HFCWO therapy can be considerable, so long-term success depends on balancing the intensity and duration of the treatment with the patient's own tolerance and life style. No therapy can work if patients do not use it, and it has become clear that not all patients require the full "30-minute rule" therapy. To promote a patient-centered approach to treatment, clinicians should consider adding flexibility in the prescription for HFCWO therapy and not feel constrained to the standard prescription. Here, we propose *adaptive HFCWO therapy*, where the patients are empowered to understand their symptoms and adapt the duration of treatment to their own personal needs in coordination with their healthcare team. Symptom tracking and adherence monitoring can provide important feedback to both patients and their healthcare teams. This regimen is intended to provide an optimal amount of therapy without unduly adding to treatment burden.

Discussion

High frequency chest wall oscillation (HFCWO) is a wellestablished airway clearance approach that has been demonstrated as a therapy to help clear the lungs of secretions in patients with different types of lung disease (eg, cystic fibrosis (CF), bronchiectasis, and COPD) or in certain neurodegenerative disease states in patient populations who are unable to clear secretions from the lungs (eg ALS, Parkinson's Disease).¹ Although many of these chronic disease states cannot be cured and treatment plans depend on the severity of the symptoms, airway clearance is a critical part of the treatment regimen and solution. The goal of HFCWO is to loosen mucus that has pooled in the airways so patients can cough it up more easily. The need for airway clearance is one of the 'treatable traits' of these disease states that HFCWO therapy can address.² Originally developed by Warwick and Hansen,^{3,4} HFCWO devices

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Unfortunately, low adherence is a major challenge in the treatment of chronic respiratory conditions.^{20,21} For example, in CF it has been reported that adherence is 50% or less for pulmonary medications, airway clearance, and enzymes.^{22,23} Factors associated with poor adherence include barriers such as treatment burden, time management difficulties, patient fatigue, and limited perceived health benefit.24 The negative consequences linked to poor adherence are profound and include higher health care costs, reduced quality of life, increased exacerbations, and earlier mortality.20,25 It is increasingly recognized that effective treatment leads to better adherence²⁶ while low adherence leads to suboptimal outcomes such as reduced health and well-being, lower productivity, disease relapse/exacerbation, and unscheduled use of more expensive health care resources.^{27,28} The number and length of required treatments certainly adds to the patient perception of treatment burden, though it is possible that familiarity with the treatment will increase the patient's acceptance of the required time commitment and improve adherence.²⁶ Additionally, treatment needs in many chronic respiratory conditions may ebb and flow in response to changing patient conditions, and calls for an adaptive strategy for HFCWO care. These, in turn, may lead to decreased health and added treatment burden down the line. The time burden for therapy is often high, and is a particular issue for HFCWO.^{24,29} Data from a large registry study in bronchiectasis show that optimal outcomes and response to vest therapy requires a period of time for patients to acclimatize and report the benefits of treatment.³⁰

The prescription or dosage recommended for HFCWO is often fixed at two times a day for 30 minutes. It is interesting to note that this '30 minute rule' was originally recommended to approximate the time used in manual chest physiotherapy,³¹ which is a very time-consuming and resource-intensive treatment. Moreover, in the early development of HFCWO techniques, pioneering studies found that each individual had a pressure-frequency combination that worked optimally.³² All current systems available on the market incorporate multiple frequencies over the course of a treatment session, which can require considerable time. Successful treatment balances the need for time spent in therapy with the individual patients' capacity to meet this need. Even when the need is great, patients lead busy lives and often struggle to find time to be adherent with all of their therapies. In patients using HFCWO therapy, the result may be a substantial burden of treatment, or else significant non-adherence.²⁷

Despite over two decades of experience with HFCWO, there has been remarkably little change in the recommended dosage for this airway clearance technique. A 'one size fits all approach' to dosing is unlikely to be the most appropriate way to approach airway clearance with vest therapy given the increased understanding we have of chronic lung disease states and patient behaviors. In this paper, we suggest a more tailored patient-centric approach intended to help this long-standing problem. Interventions that seem burdensome, are scheduled too frequently, or require too much patient effort will often result in non-adherence.²⁷ More is not necessarily better if it increases the patient burden. To facilitate positive patient outcomes, the optimal dose for an intervention should be considered as the regimen which results in maximum adherence (at the maximum tolerable time and pressure) at minimum treatment *burden*. As we enter the era of personalized care, prescribers should consider the concept of *adaptive HFCWO treatment* to better balance treatment burden and adherence to achieve the desired outcomes.

Although not a new idea, the adaptive treatment strategy is a patient-centered approach that tailors HFCWO treatment delivery in a dynamic way that meets the patients' changing needs/symptoms and addresses their immediate treatable traits.³³ The adaptive process alters the duration and/or magnitude of the treatment based on how the patient is actually feeling. Chronic lung conditions are not static and patient symptoms evolve as a function of the disease state as well as a function of the treatment itself. Treatment burden in a majority of chronic conditions changes over time in response to disease severity and comorbidities. The underlying assumption of this proposal is that optimal dosing will change over time and treatment plans that do not adjust to the patient's needs may unnecessarily lead to patient overburden or treatment fatigue.

A schematic flow of the adaptive HFCWO treatment approach is illustrated in Figure 1. From a clinical perspective, the adaptive approach should be based on two pillars. The first pillar is based on the patients' self-reported symptoms, principally their sputum production and cough. The second pillar is the patients' index of their overall sense of well-being (eg their overall energy level, difficulty breathing, etc.). In a condition when sputum production is low and their sense of well-being is high, the patient should be empowered by a more flexible prescription to reduce the number of sessions per day or to reduce the duration of each treatment to 15 minutes per session rather than the default 30 minute recommendation. The patient could possibly continue on this dosing regimen for one week and then monitor or reassess their symptoms and state of well-being to determine if there has been any notable change to report to their healthcare team. If they are stable or are experiencing improvement, the patient (with guidance and coaching from their healthcare team) could then elect to either keep their therapy time and pressure settings the same or reduce the treatment duration even further as long as their condition is stable. When sputum production is high or their sense of well-being is low, they could increase the number of sessions to two per day and increase the duration



Figure 1. Schematic Flow of Adaptive High Frequency Chest Wall Oscillation (HFCWO) Therapy

back up to at least 30 minutes. For example, if the patient reports that they 'feel it in my chest and I can't bring it up', this indicates a low sense of well-being and calls for a change in treatment. If the patient is reporting that their chest is full, are experiencing shortness of breath, and lack energy, then the treatment need is higher and they should increase the dosage of the treatment at the maximum tolerable pressure. Alternatively, as treatment starts to take effect and they feel more energetic and report that lung secretions are effectively being cleared, they could opt to decrease their therapy time. The adaptive HFCWO treatment approach would be enabled by a more flexible prescription provided by the healthcare provider. There will of course be a dynamic balance between when to use the device more and when to use the device less at different stages of the disease. But in general, patients should set the HFCWO device to highest tolerable pressure setting and then alter the therapy time as needed.

Promoting patient action and positive healthy behaviors is a guiding principle in chronic respiratory care. Such an adaptive approach personalizes care and has several potential benefits. In addition to reducing the perceived burden of treatment, a dynamic adaptive dosing strategy enables the patient to establish a feedback loop with their own body thereby promoting selfefficacy. An adaptive approach to dosing and treatment also fosters increased dialogue and engagement with the healthcare team and empowers the patient to make reason-based decisions on their own treatment. The opportunity to facilitate patient engagement with their own treatment and with their healthcare team is an important goal of an integrated adaptive titration approach. With a tailored approach, the patients become actively engaged not only in their own treatment, but also in self-awareness of their own symptoms. Symptom tracking is urged, allowing the patient to take ownership of the therapeutic process. Importantly, this process may be used by the healthcare team to foster conversations and better treatment. Clinicians recognize that adherence to therapy requires clear and coherent communication between the patient and healthcare team to ensure that treatments are maximally effective. Providers rely on patients carrying out health/treatment recommendations as directed, to optimize patients' health outcomes and improve health-related quality of life. The benefit of this approach is that it enables new partnerships, collaborative discussions,

cooperative efforts, helps alleviate treatment burden, and tailors treatment regimens to the realities of people's daily lives.

The future of chronic care of respiratory conditions is evolving rapidly. Personalized and patient-centered approaches are not new in pulmonary medicine and rehabilitation. In fact, adaptive approaches to respiratory care and HFCWO therapy were suggested early on in the care of CF patients. However, dosing recommendations for HFCWO therapy have changed little during this time. As next generation digital technologies to monitor patient symptoms and recent developments in connected care approaches are being integrated into HFCWO devices and treatment of chronic respiratory diseases, we are entering an exciting era of HFCWO treatment and pulmonary rehabilitation for chronic respiratory conditions. Understanding adherence patterns in patients using noninvasive vest therapy will likely provide a way to deliver more person-specific interventions. The tools and platforms implemented in new HFCWO devices that include monitoring will allow objective measurement of critical elements of treatment burden such as the number of treatments and time of administration. Digital data with symptom trackers and time of device use data will revolutionize the ability of respiratory healthcare system stakeholders (patients, providers, healthcare team members) to make data-driven treatment decisions and clinical recommendations. Objective data of targeted interventions based on personal adherence patterns may be cost-effective and result in considerable cost-savings. For research, the ability to log individual patient data from large numbers of patients anonymously may also enable modeling studies to document the utility of personalizing doses between patients in heterogeneous respiratory diseases. We predict that with the next developments in technology, significant progress will be made in further improving and optimizing HFCWO therapy to enhance overall patient outcomes.

Conclusion

Our current proposal on adaptive HFCWO therapy is based on prior experience, increased knowledge, and clinical experience. It is time to fit personalized and connected care approaches for treatment of chronic respiratory conditions in the evolving healthcare ecosystem. It is our hope that these innovative tools in conjunction with clinically relevant data-driven modifications will address the barrier of adherence and facilitate the uptake of HFCWO therapy for patients who need them.

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