CASE REPORT

Use of an oscillatory PEP device to enhance bronchial hygiene in a patient of post-H1NI pneumonia and acute respiratory distress syndrome with pneumothorax

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SUMMARY

A 26-year-old, 14 week pregnant woman was admitted to our hospital with pneumonia with acute respiratory distress syndrome in an intubated and mechanically ventilated state. She was diagnosed to have polymicrobial infection and left-sided pneumothorax and was put on a ventilator for 2 weeks. Postextubation, she found it difficult to clear her respiratory secretions despite aggressive routine chest physiotherapy. She was planned to undergo a mini-tracheostomy for tracheobronchial toileting. However, before that, she was given a trial of Acapella, a hand-held oscillatory positive expiratory pressure (OPEP) therapy device, for facilitating airway clearance, with the aim to speed up the recovery. The patient found it easy to use and clear the secretions optimally, thus averting a mini-tracheostomy. This case report highlights the advantages of the OPEP therapy device in effective management of bronchial hygiene in patients with poor respiratory effort.

BACKGROUND

The current devices of respiratory physiotherapy are offered as an adjunct to conventional chest physical therapy to promote the mobilisation and removal of airway secretions in patients with impaired ability to cough. These devices have been designed to enhance the patient's compliance and independence. A hand-held airway clearance device, Acapella is one such device which facilitates airway clearance with much ease. It is less time consuming and offers greater independence. The numbers of published reports on Acapella are limited and more studies are needed to evaluate the efficacy of this novel airway clearance device.

CASE PRESENTATION

A 26-year-old, 14 weeks pregnant woman was admitted to the emergency department of a nearby hospital with symptoms of high-grade fever and dry cough (on and off) since 1 week and sudden onset of breathlessness since 2 days. She was initially managed with broad-spectrum antibiotics and non-invasive ventilatory support. However, she continued to deteriorate, requiring intubation and mechanical ventilation.

After 4 days of not making any significant improvement, the patient was transferred to our super specialty hospital, Fortis Flt. Lt Rajan Dhall Hospital, Vasant Kunj for further management. She was continued on intravenous antibiotics, nebulised bronchodilators and other supportive medications. She was put on high ventilatory support with 100% fractional inspired oxygen (FiO_2).

Her laboratory reports showed high total leucocyte count (23.2), normal kidney function test, deranged liver function test (serum glutamic oxaloacetic transaminase−114, serum glutamic pyruvate transaminase−71, lactate dehydrogenase−769, alkaline phosphatase-32.7). Her haemoglobin was low (10) and procalcitonin was 0.57. arterial blood gas ABG showed pH −7.27, pCO_2 −62, pO_2 −75.6, HCO_3 −27.9 and lactate −1.6. Chest X-ray showed bilateral consolidation.

She was detected to have PCR positive for H1N1 influenza; her endotracheal secretions grew multidrug resistant acinetobacter baumanii and blood culture grew multidrug resistant enterobacter cloacae while her urine culture showed growth of non-*candida albicans*. Antibiotics were modified according to sensitivity and antivirals added. 48 h later, the patient developed spontaneous pneumothorax on the left side for which an intercostal tube was inserted and ventilator strategies modified. Extensive chest and limb physiotherapy was continued. She showed gradual but consistent response to therapy and could finally be liberated from the ventilator after 2 weeks. However, postextubation, although the patient was fully conscious and maintaining her vital parameters, she was extremely weak and had developed a flaccid paresis of all four limbs, attributed to a possible critical care myoneuropathy. She also found it difficult to cough effectively and clear her airways because of which her oxygen saturations would fluctuate, dropping down to 80% whenever the airways were choking with secretions. Chest X-ray showed signs of atelectasis. The quantity of sputum was measured to be 40 mL/day. The sputum was light yellow in colour, thick and odourless. Chest auscultation findings revealed bilateral decreased breath sounds. She was being considered for a mini-tracheostomy to enhance her bronchial toileting. However, before conducting a procedure as invasive as mini-tracheostomy, it was decided to give the patient a trial of Acapella (Smith's Medical, Watford, UK), a hand-held oscillatory positive expiratory pressure (OPEP) device.

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TREATMENT

The patient was managed with mucolytics and antibiotics, which were modified according to sensitivity patterns of the microbial pathogens isolated. An intercostal tube was inserted and allowed to drain until the pneumothorax resolved. Extensive chest and limb physiotherapy was carried out throughout her stay. Postextubation, the patient was encouraged to use the Acapella device as per the following regimen[1]:

- Slow and deep inhalation followed by controlled active exhalation to functional residual capacity (FRC)
- 10 breaths in a row
- 3 huff cough manoeuvres
- 3–4 repetitions
- 3–4 sessions per day.

The device was used in a sitting or semi-reclining position.

The patient followed the recommended technique and was able to clear secretions without much effort and exhaustion. She was very comfortable using it and was also successful in averting a mini-tracheostomy.

OUTCOME AND FOLLOW-UP

The following parameters were assessed and recorded to monitor the effectiveness of the hand-held OPEP Acapella Device:

- Chest X-ray—every 24 h
- Sputum (amount, colour and odour) every 24 h
- Chest auscultation before and immediately after the session
- Oxygen saturation, pulse rate, respiratory rate and blood pressure were continuously monitored throughout the session.

With the use of Acapella, the patient was very easily able to clear her airway secretions. The chest radiograph showed a consistent improvement day by day and signs of resolution of atelectasis within a week. The signs of pneumothorax disappeared completely and the intercostal tube was removed on the fifth day postextubation. The amount of sputum decreased significantly within a week and was about 10 mL/day and almost nil in another week. The colour of the sputum faded away in a week. Chest auscultation improved after each session. After a week, it showed increased aeration in the basal areas that were previously reduced. Her oxygen saturations were maintained well above 90% throughout the procedure. There were no significant alterations in parameters such as heart rate, respiratory rate and blood pressure during and after using the device. Cough reflex improved with time. The above regimen was followed for 2 weeks. Thereafter, the patient remained stable, completely free of secretions and was successful in averting an invasive procedure like mini-tracheostomy.

DISCUSSION

Chest physiotherapy (CPT) is an integral part in the management of invasive ventilated patients. It is considered as a 'gold standard' for the mobilisation and removal of airway secretions in patients with respiratory dysfunction, especially in chronic lung disease such as cystic fibrosis, bronchiectasis, bronchitis, bronchial asthma and primary ciliary dyskinesia syndrome.[2] The conventional regimen of CPT includes percussion, vibration and compression with or without postural drainage and assisted coughing. However, CPT can be uncomfortable for some patients and may be refused, resulting in deleterious consequences.

With the advancement of technology, respiratory rehabilitation devices for airway clearance have emerged, which are less time-consuming and offer greater independence to the patient with impaired airway clearance. These devices facilitate and improve mobilisation of mucus from the airways to achieve better lung ventilation and improved pulmonary function, resulting in better patient compliance and reduced chances of respiratory complications.[3] These devices seem to increase the patient's compliance to daily treatment, because they present many benefits such as independent application, full control of therapy and easy use.

OPEP devices have been utilised as an adjunct to conventional chest physical therapy to promote the clearance of respiratory secretions in individuals with impaired ability to cough.[4] It combines the purported benefits of positive expiratory pressure (PEP) therapy and vibration therapy to mobilise pulmonary secretions.[5 6] In PEP therapy, the patient draws air with a one way valve and exhales into a resistance in the device to create positive pressure in the lung, moving the accumulated mucus to larger airways where it can be coughed out.

The benefits of PEP therapy include the ability to increase and promote airway clearance by preventing airway collapse by stenting the airways[7] or by increasing intrathoracic pressure distal to retained secretions by collateral ventilation or by increasing FRC.[8] The oscillations enhance airway clearance in two ways. It helps to decrease the viscoelastic properties of mucus and produce short bursts of increased expiratory airflow that transport the mucus up the airways.[9]

Secretions removal is then facilitated by the patient forcing deep exhalations through the device with subsequent coughing and/or huffing techniques.[10]

Among the various types of OPEP devices, Flutter and Acapella are commonly used, easily available worldwide and cost effective.

The Flutter is a small hand-held device shaped like a pipe, which contains a high-density stainless steel ball resting in a plastic circular cone inside the bowl of a pipe. The cover over the ball has perforations that allow expiratory airflow to pass through the device. The frequency of oscillations can be modulated by changing the inclination of the Flutter device slightly up or down from its horizontal position.[10 11] This device requires an adequate position for maximum efficacy and proper operation. The Flutter produces oscillations in the range of 8–26 Hz.[12]

The Acapella (Smiths Medical, Watford, UK) operates on the same principle as the Flutter, that is, a valve interrupting expiratory flow generating oscillating PEP. The oscillations are produced when the patient exhales through a counterweighted plug and magnet.[5 6] The frequency of oscillation of Acapella is found to be 13.5 Hz (10.0–18.3), higher than other airway clearance devices and techniques that is, Flutter 11.3 Hz (7.5–13.7).[13]

Acapella can be used with a mask or mouthpiece and can be used concomitantly with nebulisation aiming to optimise its performance in bronchial hygiene.[5 6] These attributes may offer the Acapella some advantages over the Flutter.

The Acapella is an oscillatory device where the resistance can be modulated and is not position dependent.[6] Unlike the Flutter, it can be used easily in postural drainage positions without compromising patient comfort or efficacy of treatment.

In a bench study comparison of two OPEP devices, Acapella and Flutter, Volsko *et al*[6] concluded that these devices have similar operating performance characteristics in pressure amplitudes and frequencies. However, it showed a slight advantage for the Acapella, with more stable airflow oscillations (less variation in amplitude and frequency) and a slightly wider range of PEP at low air flow than the Flutter. Volsko *et al* commented that Acapella's performance is not gravity-dependent (ie, dependent on the device and/or patient orientation) and may be easier to use with some patients, particularly at low expiratory flows.

In conclusion, a hand-held Oscillatory PEP device Acapella offers an acceptable, user-friendly method of airway clearance in patients with impaired airway clearance abilities. Acapella maximises therapy effectiveness and thereby empowers patience compliance.

Learning points

- Chest physiotherapy (CPT) is an integral part in the management of bronchial hygiene, and these Oscillatory positive expiratory pressure (OPEP) devices are offered as an adjunct to conventional CPT in the mobilisation and removal of secretions.
- Inability to clear secretions can be very challenging in postextubated patients. With the use of the OPEP device, the amount of sputum decreases significantly, indicating better clearance of secretions.
- A hand-held OPEP device, Acapella was found to be effective in facilitating airway clearance in a pregnant lady choking on to her airway secretions following H1N1 pneumonia & ARDS, in the postextubation period.
- Acapella is self administered, easy to use and easy to learn and requires no second person to provide the therapy.

Competing interests None.

Patient consent Obtained.

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