Validation of AirPhysio Oscillating Positive Expiratory Pressure Device – Short Paper

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Background

The AirPhysio device is a new OPEP device designed and manufactured in Australia (Figure 1). The AirPhysio device is a handheld pipe like device with a stainless steel ball seated in a conical cone. The manufacturers included several original design features in the device including a dual cone and a modified cap that allows 3 different ball bearings (19, 20 and 22 mm) to be fitted. The device is made from a robust polycarbonate plastic, which the manufacturer suggests makes it more durable. It has been designed to sit flat on the benchtop with the mouthpiece elevated for improved hygiene. In a further attempt to improve hygiene the device includes a cap to go over the mouthpiece.

Being new on the market, the performance of the AirPhysio device has not been compared with other PEP devices such as the Flutter.

Figure 1. AirPhysio Device

Introduction

For lung diseases that result in excess secretions, airway clearance techniques which improve mucus clearance are considered to be essential for optimising respiratory status and reducing disease progression [1]. In the conducting airways lined by ciliated epithelial cells, secretions are cleared by the mucocillary escalator; an essential component of the lung defence protecting the lung and gas exchange regions from inhaled particles and bacteria which may lead to infection. Mucus generating goblet cells produce a mucus film that sits on top of the cilia. The rhythmic beating of the cilia acts as an escalator that moves the mucus from the smaller peripheral airways to the larger central airways. From these larger airways mucus and any trapped inhaled particles or bacteria can be cleared, typically using a forced expiratory technique such as a cough or a huff.

There are a number of airway clearance techniques. The primary aim of these techniques is to shear mucus and excess sputum from the inner surface of the airway lumen in the direction of the larger airways[2]. To achieve this, airway clearance techniques apply external forces to the lungs and airways that manipulate lung volumes, pulmonary pressures and gas flow [2, 3]. Examples of airway clearance techniques include postural drainage, percussion,

breathing exercises and positive expiratory pressure (PEP).

Positive expiratory pressure devices can be used to assist airway clearance in individuals with excess secretions [3]. Originating in Denmark and defined as 'the PEP technique', Falk et al [4] described an airway clearance method which required the subject to breathe through a flow dependent PEP device attached to a face mask that created a PEP of between 10 and 20 cmH_20 for 12 to 15 breaths.

Theoretically, PEP assists airway clearance several ways. The addition of positive resistive pressure as the participant breaths out results in a prolongation of expiration which in turn may increase expiratory capacity and a reduction in gas trapping [5]. Moreover it is proposed that PEP stabilises and splints the airways open [6] and increases the gas pressure behind excess mucus via collateral ventilation resulting in a temporary increase in functional residual capacity (FRC) [7]. As the individual breaths through the PEP device, FRC is gradually increased [1]. By increasing the gas pressure behind the mucus, forced expiratory techniques may be more effective in moving excess secretions from the peripheral to central airways [1, 7].

Oscillating high frequency PEP (OPEP) devices combine both PEP and airway oscillation techniques. The most well-known OPEP device, the Flutter, originated in Switzerland [3]. An early study by Konstan and colleagues [8] described the efficacy of the device for airway clearance in 18 cystic fibrosis patients. The authors reported there were no adverse events with the device and that patients expectorated significantly ($p<0.001$) greater amounts of sputum when compared to airway clearance technique of postural drainage and voluntary cough.

The Flutter device is a handheld pipe like device with a stainless steel ball seated in a conical cone inside the bowl of the pipe (Figure 1). A screw top lid with perforations to allow airflow through the device sits on top of the pipe. As the subject breaths out through the device the ball moves up and down creating an opening and closing cycle as the stainless steel ball is lifted off and then reseated on the cone throughout expiration [8]. These opening and closing cycles result in oscillations of endobronchial pressure and expiratory airflow which coincide with the opening and closing cycle of the ball being seated and lifted from the cone [8] (Figure 1). It is hypothesised that these additional oscillations may enhance sputum clearance by decreasing the viscoelastic properties of sputum and improved clearance through the airways.

Recent Cochrane reviews in individuals with cystic fibrosis, bronchiectasis and following an acute exacerbation of chronic obstructive pulmonary disease (AECOPD) suggest that airway clearance techniques are safe and may confer some benefit on clinical outcomes [1, 2, 9]. In AECOPD, there was a greater magnitude of the effect for PEP over non- PEP airway clearance techniques on the need for ventilatory assistance and hospital length of stay [2]. In a large randomised controlled trial comparing PEP with no airway clearance during a hospital stay for AECOPD, resting breathlessness improved more rapidly in the group allocated to PEP when compared control in the first 8 weeks following intervention. However these authors found no difference in patient reported symptoms, quality of life or exacerbations at 6 months [10]. The recently published Cochrane review by McIlwaine et al [1] examined the use of PEP devices in individuals with cystic fibrosis. Using outcomes such as changes in lung function, mucus cleared from the airways and quality of life, the authors reported that efficacy of PEP was similar to other forms of chest physiotherapy. Of note these authors compared the efficacy of PEP and OPEP and found similar results for both techniques. However it is worth noting that one long-term randomised controlled trial of children with cystic fibrosis that compared PEP and OPEP reported greater declines in lung function (forced vital capacity) and greater rates of hospitalisations in individuals that used flutter (ie OPEP) when compared to PEP [11].

Publication Note

References

1. *McIlwaine, M., B. Button, and K. Dwan, Positive expiratory pressure physiotherapy for airway clearance in people with cystic fibrosis. Cochrane Database Syst Rev, 2015(6): p. CD003147.*
2. Osadnik, C.R., C.F. McDonald, A.P. Jones, and A.E. Holland, *Airway clearance techniques for chronic obstructive pulmonary disease.* Cochrane Database Syst Rev, 2012(3): p. CD008328.
3. Pryor, J.A., *Physiotherapy for airway clearance in adults.* Eur Respir J, 1999. **14**(6): p. 141824.
4. Falk, M., M. Kelstrup, J.B. Andersen, T. Kinoshita, P. Falk, S. Stovring, and I. Gothgen, *Improving the ketchup bottle method with positive expiratory pressure, PEP, in cystic fibrosis.* Eur J Respir Dis, 1984. **65**(6): p. 423-32.
5. Osadnik, C.R., C.F. McDonald, and A.E. Holland, *Advances in airway clearance technologies for chronic obstructive pulmonary disease.* Expert Rev Respir Med, 2013. **7**(6): p. 673-85.
6. *Oberwaldner, B., J.C. Evans, and M.S. Zach, Forced expirations against a variable resistance: a new chest physiotherapy method in cystic fibrosis. Pediatr Pulmonol, 1986.* **2***(6): p. 358-67.*
7. *Myers, T.R., Positive expiratory pressure and oscillatory positive expiratory pressure therapies. Respir Care, 2007.* **52***(10): p. 1308-26; discussion 1327.*
8. *Konstan, M.W., R.C. Stern, and C.F. Doershuk, Efficacy of the Flutter device for airway mucus clearance in patients with cystic fibrosis. J Pediatr, 1994.* **124***(5 Pt 1): p. 689-93.*
9. Lee, A.L., A.T. Burge, and A.E. Holland, *Airway clearance techniques for bronchiectasis.* Cochrane Database Syst Rev, 2015(11): p. CD008351.
10. Osadnik, C.R., C.F. McDonald, B.R. Miller, C.J. Hill, B. Tarrant, R. Steward, C. Chao, N. *Stodden, C.C. Oliveira, N. Gagliardi, and A.E. Holland, The effect of positive expiratory pressure (PEP) therapy on symptoms, quality of life and incidence of re-exacerbation in patients with acute exacerbations of chronic obstructive pulmonary disease: a multicentre, randomised controlled trial. Thorax, 2014.* **69***(2): p. 137-43.*
11. *McIlwaine, P.M., L.T. Wong, D. Peacock, and A.G. Davidson, Long-term comparative trial of positive expiratory pressure versus oscillating positive expiratory pressure (flutter) physiotherapy in the treatment of cystic fibrosis. J Pediatr, 2001.* **138***(6): p. 845-50.*
12. *Volsko, T.A., J. DiFiore, and R.L. Chatburn, Performance comparison of two oscillating positive expiratory pressure devices: Acapella versus Flutter. Respir Care, 2003.* **48***(2): p. 12430.*