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Physiological effects of Simeox Airway Clearance Device in healthy adults

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INTRODUCTION

Airway clearance devices (ACDs) assist in mobilizing retained secretions in lung diseases by increasing the velocity of expiratory flow in such a way as to create high shearing forces on the airway walls, and high kinetic energy that enhances the cephalad movement of secretions.

Mucus clearance can be modelled as a two-phase gas-liquid flow mechanism. The oscillatory vibrations on expiration assist in loosening and mobilizing the secretions in three essential ways:

- **1.** by altering the rheological properties of mucus rigidity (sum of viscosity and elasticity) and spinnability (thread forming capacity of mucus);
- 2. by creating an expiratory flow bias that shears mucus from the airway walls and supports its movement proximally. Peak expiratory flow rate (PEFR) must exceed 30–60 L•min-1 to overcome the adhesive strength by which the mucus is attached to the interface; and
- **3.** by enhancing ciliary beat frequency. Oscillation frequencies of 11-15Hz increase mucus clearance from 8.2 mm·min-1 to 26 mm·min-1, which corresponds to the ciliary beat frequency.

AIM

Aim of this study was to characterize oscillatory flow and negative expiratory pressure pulses generated by a new ACD (Simeox, PhysioAssist) in healthy subjects.

METHODS

10 healthy adults activated Simeox that generates intermittent pulses of intrapulmonary negative air pressure during non-forced exhalations (4 to 6-second duration). The procedure was repeated twice with 4 settings (25% or 100% power at 6 or 12 Hz frequency). Oscillatory flow (Fig 2) and pressure pulses were measured at the mouth with a flow sensor (TSI, Certifier FA plus) to assess Maximal expiratory flow (MEF), maximal mid-expiratory flow (MMEF), Mean expiratory flow (EFmean), maximal expiratory flow amplitude (MEFamp), peak of negative expiratory pressure (NEPpeak) and maximal expiratory pressure amplitude (MEPamp).

RESULTS

60% male, 34±12y, FEV1/FVC 90±14%. Data are presented in table 1. MEF (60 to 120 l/min) and MEFamp (70 to 140 l/min) rates supported generation of high airflow velocity during exhalation over power range. Oscillatory flow was maintained at mid-exhalation.

Rising device power from min to max, increased flow and negative pressure by > 50%.

(-10 to -60 mbar).

Table 1: Expiratory flow and negative expiratory pressure pulses

Frequency		6 Hz			12 Hz	
Power	25%	100%	P100%-25%	25%	100%	P100%-25%
MEF I/min	71.1±4.9	111.9±3.9	40.8±3.9	62.6±4.7	104.8±3.4	42.2±3.1
MMEF I/min	63.9±4.5	103.6±4.8	39.7±3.5	56.8±3.7	96.6±4.6	39.8±3.3
EFmean I/min	11.1±3.2	21.3±4.7	10.2±3.3	10.7±4.0	22.8±4.0	12.1±4.2
MEFamp I/min	84.6±4.2	134.1±4.9	49.5±2.8	78.1±5.6	129.2±4.5	51.2±3.9
NEPpeak mbar	-26.4±6.3	-43.8±8.8	-17.4±5.8	-24.9±10.4	-44.2±10.9	-19.3±9.0
MEPamp mbar	-23.2±5.0	-37.8±8.8	-14.6±6.4	-22.4±4.1	-34.9±4.3	-12.4±4.0

CONCLUSION

clearance therapy.

Low variability of data showed high reproducibility of oscillatory flow (Fig 3a and b) and negative pressure pulses generated with Simeox during procedure. Range of pressure pulses was safe

These data suggest that Simeox may be an efficient and secure technology for airway

Fig 1: test procedure with Simeox hvsioAssist





