# Comparison of Mechanical Insufflation-Exsufflation Using a Stand Alone Device and Integrated into a Ventilator

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## INTRODUCTION

Mechanical insufflation-exsufflation (MI-E) enhances secretion clearance in patients with neuromuscular disease. MI-E simulates a cough guided by the cough peak flow (CPF). Since inception, MI-E has required a stand-alone device. We compared a standard MI-E device (T-70, Philips, PA) to MI-E integrated into a ventilator (VOCSN, Ventec Life Systems, WA) in a bench model.

## METHODS

Each device was connected to an ISO rigid lung model with CL set at 50 or 80 mL/cm $H_2O$ and Raw of 10 cm $H_2O$/L/s via standard circuits (passive and active). Devices were set at 3 different inspiratory/expiratory pressure settings (+30/-30, +50/+50, and +30/-50 cm $H_2O$) and 2 inspiratory rise times (fast and slow). Insp and Exp times were fixed at 3.0 secs with no pause time. We measured airway pressures, volumes and flows using a Citrex H5 Analyzer (IMT Analytics, SZ) at 500 Hz and calculated peak PIF and PEF, the duration of time PEF was > 90% (T90), IP, EP and delivered VT. Median and ranges were calculated and compared between the T70 and the VOCSN with a passive (Vp) and active (Va) circuit.

Artificial mucus (1 mL) was placed in an 8 mm ID clear tube over a 2-4 cm distance. Photographs were taken before and after 3 cough cycles and video was recorded for each of 3 trials using a 12 mp camera. Photos were imported to a PC and the distance mucus moved antegrade and retrograde was determined.

Net mucus movement was determined as the difference between antegrade and retrograde distance measured at the most proximal and distal edge of the mucus. Mucus movement was compared using Wilcoxson rank sum test, a $p < 0.05$ was significant. Airway pressure and flows were expressed as median (range) and compared using Kruskal-Wallis test.

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Dr Benditt and Mr. Branson disclose relationships with Ventec

## METHODS

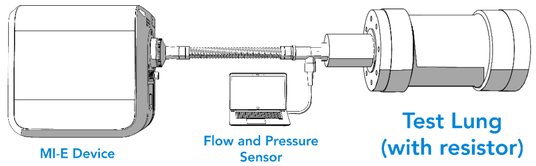



Figure 1. Test setup for measurements

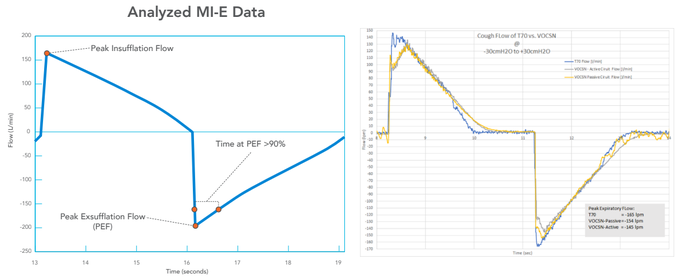


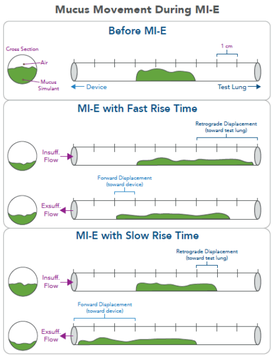

Figure 2 a and 2b Analysis of peak flow and PEF at > 90% of peak flow and actual flows

Table 1 displays the data for +30/-30 cm $H_2O$ at the slow and fast rise time at a $C_L$ of 50 ml/cm $H_2O$. VOCSN resulted in statistically significant (p=0.049) increases in mucus movement. Factors impacting mucus movement included PIF, PIF-PEF, and $V_T$ Changes were NSS. Absolute PIF and PEF were higher with T-70 but were not statistically different (p=0.121). T90% was longer with VOCSN , but not statistically significant (p=0.121).

## RESULTS

Table 1 Median and range for study results for +30/-30 cm $H_2O$.

| Device | Rise Time | PIF* (LPM) | PEF* (LPM) | $T_{90\%}$* (Secs) | Net mucus movement (cm) |
|---|---|---|---|---|---|
| T70 | S | 84(84,85) | 163 (162, 164) | 0.215(0.205, 0.235) | 3.0 (2.90, 3.33) |
| VOCSNa | S | 109 (107,109) | 146 (143, 146) | 0.340 (0.310, 0.364) | 2.2(1.25, 2.4) |
| VOCSNp | S | 110 (107, 113) | 156 (154, 158) | 0.220 (0.219, 0.233) | 3.42 (2.85,4.05) |
| T70 | F | 150 (148, 153) | 168 (167,172) | 0.205 (0.175, 0.215) | 1.1(0.4,2.1) |
| VOCSNa | F | 134(133,136) | 146 (145,147) | 0.372 (0.369, 0.372) | 1.7 (1.1, 1.85) |
| VOCSNp | F | 126 (125, 131) | 156 (154, 158) | 0.161 (0.155, 0.162) | 2.7 (2.55, 3.0)# |




*Comparisons of PIF, PEF, and $T_{90\%}$ between devices were not significant Kruskal-Wallis test p =0.121
# Mucus movement at fast rise time was greater with VOCSNp (p=0.495)

Figure 3. Schematic of artificial mucus movement demonstrating impact of PIF

## CONCLUSION

- Net artificial mucus movement was greater with VOCSN in 9 of 16 conditions.
- Our data confirms that faster rise times reduced net mucus movement and that PEF alone is not the primary determinant of MI-E success.
- Flow and pressure values were comparable between devices. The clinical importance of these findings requires patient testing.

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