Delivery of bronchodilator drugs via aerosol generators during noninvasive ventilation (NIV) is the preferred method for management of patients with worsening COPD and acute asthma.

There is limited information about the influence of the type of aerosol device and its position in the circuit, inhaled gas humidity, pressure support settings of the ventilator and patient related factors on aerosol delivery to the lower respiratory tract during NIV.

We hypothesized that efficiency of aerosol delivery to the lower respiratory tract via aerosol generators during NIV would differ based on pressure settings of ventilator, type of aerosol devices and their position in the circuit.

### METHODS AND MATERIALS

The experimental design is shown in Figure 1.

The BipAP ventilator was set as S/T mode, non-humidified, RR 20 breaths/min, I:E ratio 1:2, V_t (300 ml), airway resistance 20 cmH_2O/l/s and compliance 0.07 l/cmH_2O, and inspiratory/expiratory positive airway pressure (IPAP/EPAP) of 10/5, 15/5 or 15/10 cm H_2O, respectively, was mimicked in vitro. Albuterol sulfate aerosols were administered via a pressurized metered-dose inhaler (pMDI) with spacer chamber, a vibrating aperture plate (VAP) and a jet nebulizer, placed sequentially at proximal, in-between and distal positions in-line in the circuit. Three experiments were performed for each of the 3 aerosol devices, at each of the 3 positions and under each of 3 pressure support settings. Drug was eluted from a filter placed at the distal ends of the bronchus and quantified by a spectrophotometer (276 nm) after each experiment.

### RESULTS

The efficiency of aerosol delivery varied significantly, depending on the type of aerosol device and its position in the circuit. Aerosol generators placed at the distal position showed the highest efficiency compared to at in-between or proximal position (P < 0.001). In general, VAP nebulizer was more efficient than jet nebulizer and pMDI (6.1 ± 2.9% vs. 3.68 ± 1.06% and 1.05 ± 0.73%, F = 111.92, P < 0.001). The IPAP/EPAP settings had lesser influence on the efficiency of aerosol delivery as shown in Table 1.

### DISCUSSION

High inspiratory flow rate and increased turbulent flow during noninvasive ventilation caused greater impaction and sedimentation of aerosol particles into the tubing, resulting in significant variability of the efficiency of aerosol delivery to the lower respiratory tract, based on the placement of aerosol devices in-line in the circuit.

The “charging effect” of the facemask and less expiratory waste of aerosol increased drug delivery when the aerosol generators were placed at distal position (between the mask and exhalation port).

Compared to pMDI, the unique characteristics of VAP nebulizer to produce low velocity aerosol particles and minimal drug residual volume enhanced aerosol delivery.

Rapid shallow breathing pattern and lower tidal volumes appeared to negate the effect of higher positive pressure support settings on aerosol delivery.

### CONCLUSIONS

During noninvasive ventilation, aerosol delivery with different aerosol generators showed significant variability.

A VAP nebulizer placed distal to the air leak in the circuit had a higher efficiency than a jet nebulizer or pMDI.

The efficiency of aerosol delivery with a pMDI would need to be significantly enhanced for this delivery method to be practical for clinical use during noninvasive ventilation.

### REFERENCES


The authors have disclosed no commercial support and relevant financial interests.