INTRODUCTION

Mechanical ventilation with High Frequency Oscillation (HFO) has emerged as an effective method to provide ventilatory support to a population of severely ill patients. While aerosol delivery during mechanical ventilation with HFO has long been considered impractical, the impact of this mode of ventilation on aerosol delivery is not well understood. Aerosol delivery from jet nebulizers during conventional volume- and pressure-limited mechanical ventilation has been limited to less than 10%, however, early reports with HFO indicate substantially less aerosol delivered than with conventional ventilation.

METHODS

We compared the ability of the Aeroneb Pro and two small volume jet nebulizers, MistyNeb (Allegiance) and Vie One (Westmed), to deliver 2.5 mg of 0.083% albuterol sulfate to a simulated pediatric patient during mechanical ventilation with high frequency oscillation.

A pediatric test lung was ventilated by a Sensormedics 3100A Oscillator with a heated humidifier (Hudson/RCI) through a 5.0 mm endotracheal tube (Figure 4). The ventilator was set to deliver a frequency of 8.0 Hz, inspiratory time of 33%, amplitude of 25 mm, and mean airway pressure of 20 cm H2O. Albuterol was collected with an absolute filter at the distal tip of the endotracheal tube and assayed by HPLC.

RESULTS

All nebulizers were operated with a fill volume of 3 ml of 0.083% albuterol sulfate (2.5 mg), and both jet nebulizers were operated with 6 L/min of oxygen. Nebulizers were run until sputter (jet), or end of aerosol generation (Aeroneb Pro). Ventilator parameters were recorded before and during nebulization for each device. Operation of the ventilator was monitored during refilling of the nebulizers, initiation of nebulization and discontinuation of nebulization. All experiments were repeated in triplicate, with data collected with an absolute filter at the distal tip of the endotracheal tube.

The Aeroneb Pro delivered more albuterol (582 ± 89 µg) to the airway of the pediatric lung model than the two small volume jet nebulizers, with no modification of ventilator parameters. This level of aerosol delivery without changes in airway pressure may make aerosol delivery during mechanical ventilation with high frequency oscillation more practical.

CONCLUSION

Our findings suggest that aerosol delivery during mechanical ventilation with HFO is possible with a variety of nebulizers, although there were wide variations in delivery and impact on the ventilator settings among nebulizers. The Aeroneb Pro delivered up to three fold more drug in vitro than either the MistyNeb or Vie One. The gas flow required to operate both of the jet nebulizers changed ventilator parameters, while refilling the jet nebulizers required interruption of ventilation. Any changes in ventilator parameters with the Aeroneb Pro were below levels of detection.

DISCUSSION

The Aeroneb Pro delivered more albuterol during HFO to the airway of the pediatric lung model than the two small volume jet nebulizers, with no modification of ventilator parameters. This level of aerosol delivery without changes in airway pressure may make aerosol delivery during mechanical ventilation with high frequency oscillation more practical.