In Vitro Comparison of Aerosol Delivery Efficiency of Vibrating Mesh Nebulizers With Different Shapes of T-Adaptors During Adult Mechanical Ventilation

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Introduction
Successful delivery of aerosolized medication within mechanical ventilation (MV) necessitates an efficient vibrating mesh nebulizer connected to a well-designed T-adaptor that is subsequently conjoined to the inlet of a heated humidifier in a closed circuit ventilator circuit. However, many traditional T-adaptors suffer from significant aerosol impaction, thus reducing drug delivery efficacy. This study compared aerosol drug delivery outcome between conventional and reengineered T-adaptors when fitted with different vibrating mesh nebulizers during adult MV.

Key word: mechanical ventilation; aerosol drug delivery; vibrating mesh nebulizers; T-adaptor; bronchodilator.

Methods

Ventilator parameters: Puritan Bennett 760 (Medtronic Pk), tidal volume 600 mL, respiratory rate 16 breaths/min, PEEP 5 cmH2O.

• Drug: a unit dose of Ventolin (Salbutamol 5.0 mg/2.5 mL, GSK).

• Nebulizers and accessories: Figure 1 showed each one of the different nebulizers (MBTC T-adaptor, Aerogen Solo) was separately connected to either MBTC T-adaptor (MicroBase Technology Corp, Taiwan), Aerogen Solo (Aerogen Inc.) or Aerogen T-adaptor (Aerogen Inc.). Median mass aerodynamic diameter (MMAD) values were shown in Table 1. Placement of nebulizers: nebulizers were placed at inlet of a heated humidifier (MR370; Fisher & Paykel).

• Placebo of nebulizers: nebulizers were placed at inlet of a heated humidifier (MR370; Fisher & Paykel).

• Drug eluted and analyzed: spectrophotometer (U-2900; hitachi Corp) at wavelength 276 nm for Combivent and 254 nm for Pulmicort.

Table 1. The particle size of four nebulizers with Andersen cascade Impactor (ACI).

<table>
<thead>
<tr>
<th>Nebulizer</th>
<th>MMAD (µm)</th>
<th>GSD</th>
<th>FPD (mg)</th>
<th>FPF (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>µmV4.0</td>
<td>2.19 1.78</td>
<td>4.36</td>
<td>69.76</td>
<td>1.88%</td>
</tr>
<tr>
<td>µmV3.0</td>
<td>2.03 1.78</td>
<td>4.36</td>
<td>69.76</td>
<td>2.03%</td>
</tr>
<tr>
<td>Aerogen Solo</td>
<td>3.31 2.11</td>
<td>2.50</td>
<td>63.18</td>
<td>1.78%</td>
</tr>
</tbody>
</table>

The newly designed larger volume MBTC T-adaptor with nebulizers demonstrated significantly greater dose (26.51 ± 4.0 vs. 18.87 ± 3.0, p<0.001). Moreover, smaller particle size generated by µmV3.0 and µmV2.0 (with MBTC T-adaptor) has demonstrated significantly greater dose (26.51 ± 1.78 vs. 30.04 ± 0.63 mg) with Aerogen Solo and 23.77 ± 2.37 vs. 30.04 ± 0.63 mg) with Aerogen T-adaptor. The difference between MBTC T-adaptor and Aerogen Solo and T-adaptor was statistically significant (p<0.001).

Conclusion

The newly designed larger volume MBTC T-adaptor with nebulizers demonstrated significantly greater dose (26.51 ± 4.0 vs. 18.87 ± 3.0, p<0.001). Moreover, smaller particle size generated by µmV3.0 and µmV2.0 (with MBTC T-adaptor) has demonstrated significantly greater dose (26.51 ± 1.78 vs. 30.04 ± 0.63 mg) with Aerogen Solo and 23.77 ± 2.37 vs. 30.04 ± 0.63 mg) with Aerogen T-adaptor. The difference between MBTC T-adaptor and Aerogen Solo and T-adaptor was statistically significant (p<0.001). This study compared aerosol drug delivery outcome between conventional and reengineered T-adaptors when fitted with different vibrating mesh nebulizers during adult MV. The newly designed larger volume MBTC T-adaptor with nebulizers demonstrated significantly greater dose (26.51 ± 4.0 vs. 18.87 ± 3.0, p<0.001). Moreover, smaller particle size generated by µmV3.0 and µmV2.0 (with MBTC T-adaptor) has demonstrated significantly greater dose (26.51 ± 1.78 vs. 30.04 ± 0.63 mg) with Aerogen Solo and 23.77 ± 2.37 vs. 30.04 ± 0.63 mg) with Aerogen T-adaptor. The difference between MBTC T-adaptor and Aerogen Solo and T-adaptor was statistically significant (p<0.001).

References


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