Introduction

The Alberta Idealized Throat (AIT) is a representative model that accurately mimics average extrathoracic deposition of orally-inhaled aerosols in adults (1-2). In the present work, we extend this model to testing of aerosol drug delivery through facemasks by adding an idealized facial geometry to the AIT. ERS Guidelines on the use of nebulizers (3) note that patients suffering acute shortness of breath are likely to mouth breathe when using a facemask; thus, a facial geometry model coupled with a mouth-throat is applicable. The utility of the AIT with face was demonstrated by assessing the fraction of salbutamol delivered to a filter downstream of the throat for three jet nebulizer-facemask combinations.

Materials & Methods

- An adult face model was created based on inspection of typical dimensions from 10 adult facial MRI scans. The face model was attached to two throat models: the original AIT and a modified AIT that allowed for smooth transition to the face model in a vertical orientation.
- Testing was performed using PARI LC Sprint (PARI, Munich, Germany) jet nebulizers (n=5) with a PARI Vios Compressor and a front-loaded facemask under both humidified (RH=78±4%) and dry conditions (RH=4±1%).
- Two additional nebulizer systems – Salter 8900 Series (n=5) (Salter Labs, Arvina, USA) and Westmed VixOne (n=5) (Westmed, Tucson, USA), each with bottom-loaded facemasks – were tested with 8 LPM nebulizer flow rates, supplied by a house source of compressed air, using the modified AIT and face under a humidified condition.
- All tests were done using 2.5 ml Salbutamol (1mg/ml) (Pharmascience, Inc., Montreal, Canada). 5 minute nebulization times and a breathing profile with TV=383ml, f=16.6 breaths/min and I/E=0.727 (4).
- Salbutamol deposited on each of the nebulizer, mask, face, throat and filter was separately extracted with water and assayed for salbutamol sulphate via UV absorbance.
- One-way, independent ANOVA with significance threshold p=0.05 was used to compare the recovered salbutamol between the three nebulizer-facemask combinations tested.

Results

- In initial testing with the LC Sprint, no significant difference in mask, face, throat or filter deposition was observed between the original or modified throat.
- Humidification did not significantly affect deposition in these initial tests.

Conclusions

- Similar deposition in the throat models suggests that the modified AIT can be used in place of the original for testing oral inhalation from a facemask.
- Ambient humidity effects on throat deposition were found to be negligible with the high output nebulizers used.
- The present addition of the face model to the AIT may be useful in the development and testing of devices with facemasks for drug delivery to the lungs.

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Table 1. Comparison of original and modified AIT under humidified and dry conditions.

<table>
<thead>
<tr>
<th>Condition</th>
<th>LC Sprint</th>
<th>Salter 8900</th>
<th>VixOne</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humidified</td>
<td>Mask</td>
<td>Face</td>
<td>Throat</td>
</tr>
<tr>
<td>Dry</td>
<td>1.25</td>
<td>1.32</td>
<td>1.41</td>
</tr>
<tr>
<td>Humidified</td>
<td>1.28</td>
<td>1.26</td>
<td>1.25</td>
</tr>
<tr>
<td>Filter</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
</tr>
</tbody>
</table>

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References