Aerosol Delivery to the Lungs Using Controlled Condensational Growth Techniques during High Flow Nasal Therapy
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Purpose
High depositional drug losses are observed in the high flow nasal therapy (HFNT) circuit components and extrathoracic airways during administration of conventional sized aerosols through a nasal cannula. This results in low (<5%) and variable drug delivery to the lungs. Controlled condensational growth techniques are evaluated to minimize drug aerosol losses and maximize the dose delivered to the lungs.

Methods
Submicrometer aerosols were generated from a mixer in combination with the Aeroneb Lab nebulizer. The nebulizer formulation was an aqueous solution containing 0.2% albuterol sulfate and 0.2% sodium chloride. For the excipient enhanced growth (EEG) technique, a streamlined cannula was employed delivering aerosol at 20L/min. For the enhanced condensational growth (ECG) technique, a divided and streamlined cannula was employed with 20L/min of aerosol delivered to one nostril and 15L/min of heated and humidified air delivered to the other nostril. The cannula was placed at the nose of an adult nose-mouth-throat (NMT) model, which was attached to a breath simulator with a filter at the exit of the trachea. Aerosol was delivered to the model either continuously or for discrete time periods (1s or 2s) synchronized with the inhalation breathing cycle. Aerosol drug deposition was determined in the NMT model and the HFNT components. The in vitro dose delivered to the lungs was estimated based on the mass collected on the filter.

Results
The emitted dose (ED) from the mixer was high (>74% of the nominal dose) for continuous, 1s and 2s delivery. Overall deposition was low in the HFNT components (<10.6%). Similarly, there was low drug deposition losses in the NMT model during ECG (<6.6%) and EEG (<3.9%) delivery. Intermittent ECG aerosol delivery produced mean (SD) lung doses of 52.1(3.1) and 52.6(2.9)% for 1s and 2s, respectively, which were greater than observed using the continuous delivery method (29.0(1.3)%). Respiratory losses were consistently lower during 1s delivery compared to 2s.

Conclusion
The use of the controlled condensational growth techniques with intermittent aerosol delivery may allow efficient pharmaceutical aerosol delivery to patients receiving HFNT.