A UNIQUE WAY OF DELIVERING AEROSOLIZED MEDICATIONS TO ADULTS:

A TRANSLATIONAL RESEARCH WITH HIGH FLOW NASAL CANNULA

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Background

High flow nasal cannula (HFNC) has been developed to promote oxygenation and positive airway pressure in critically ill patients with respiratory failure. Although HFNC was not designed for aerosol drug delivery, we developed a unique way of delivering aerosolized medications to adults using a mesh nebulizer with HFNC.

Purpose

The purpose of the in vivo study is to compare deposition and distribution of radiolabeled aerosol in healthy human subjects with HFNC at 10 L/Min, 30 L/Min, and 50 L/Min.

The purpose of the in vitro study is to determine the effect of flow rate, heat, and humidity on albuterol delivery in a spontaneously breathing adult lung model utilizing HFNC.

Methods

Figure 1 and Figure 2 show experimental set ups used with the in vivo and in vitro studies, respectively. An in vitro lung model was developed to simulate a spontaneously breathing adult using a nebulizer with HFNC. A collecting filter was connected to a heated humidifier (37ºC & 100% relative humidity) simulating BTPS exhaled humidity at the bronchi. Using a mesh nebulizer, albuterol sulfate (2.5 mg/3 mL) was administered through a HFNC (Optiflow, Fisher Paykel) with 100% oxygen at 10 L/Min, 30 L/Min, & 50 L/Min. A filter attached to the bronchi of the model collected the aerosol, eluted, and finally measured using spectrophotometry.

Figure 1: *In Vivo Study:*

A randomized crossover design

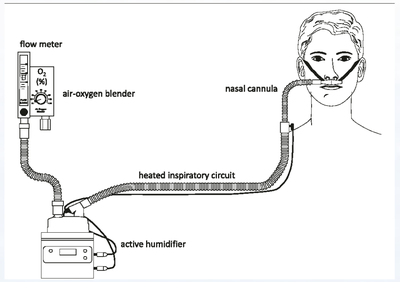
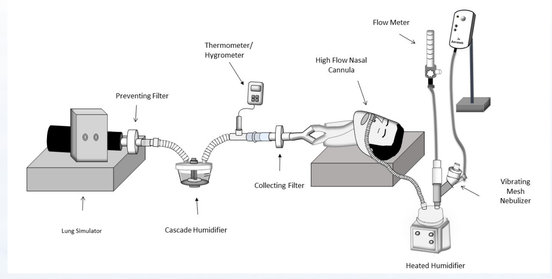


Figure 2: *In Vitro Study:*

Experimental set up with HFNC



Results

Table 1: In vivo aerosol deposition and distribution at 10, 30, & 50 L/min with heated humidifier.

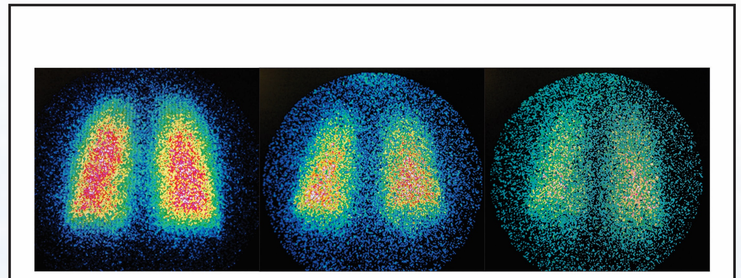
Percent (%)	10 L/Min	30 L/Min	50 L/Min	p Value
Lung (%)	11.8±4	3.8±1	2.2±.5	0.000
Airway	36.4±10	42.4±14	46.7±8	0.213
Stomach	0.25±0.1	0.7±0.3	0.3±.1	0.118
HFNC	23.4±2	28.7±2	30.2±3	0.000
Chamber	9.2±4	13.0±8	7.9±1	0.277

Table 2: In vitro aerosol deposition at 10, 30, & 50 L/min with & without heated humidifier.

	With Heated Humidifier	Without Heated Humidifier
10 L/min	11.4±0.27	13.7±0.94
30 L/min	5.33±0.18	7.01±0.63
50 L/min	2.66±0.08	4.51±0.28
p value	0.0001	0.0001

Results

Figure 3: In vivo images of radiation in lungs after inhalation of aerosol via HFNC with heated humidifier.



Reducing flow rate of HFNC increases aerosol drug delivery in adults.

Discussion

This is the first translational research to quantify lung dose of aerosol administered via HFNC. The findings of this study can guide clinicians to adjust drug dosage and/or flow rate in order to optimize lung doses in critically ill patients.

While lung deposition via HFNC was greater during administration with unheated and humidified gas, these conditions would not be well tolerated for extended periods of time.

This study with healthy subjects may underestimate lung doses in patients with respiratory distress.

Conclusion

Aerosol administration via HFNC is a viable option for delivering clinically relevant dosing to the lungs.

Target drug delivery to the lungs may be achievable with dose adjustments based on factors such as flow rates and presence of heated humidity.