

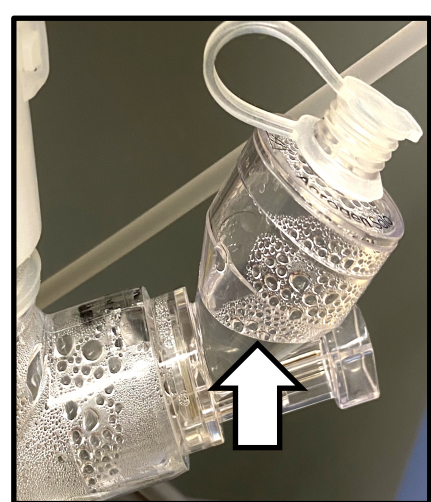
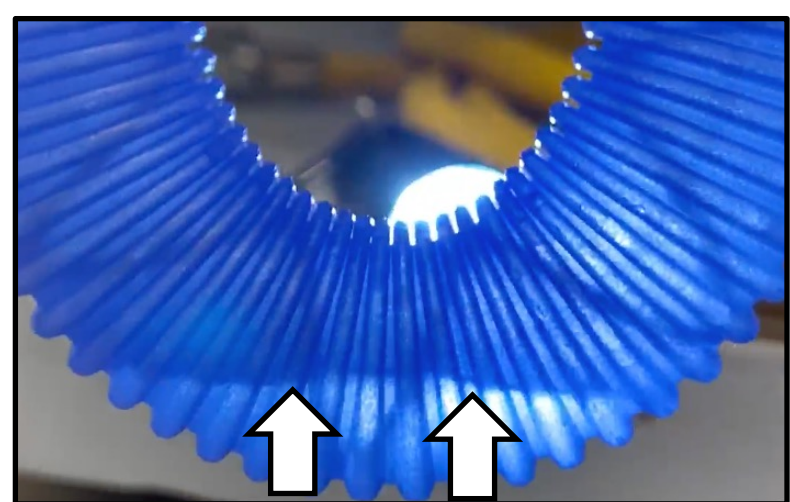
Aerosol Delivery via Nebulization from the Dry Side of a Heated Humidifier During Mechanical Ventilation

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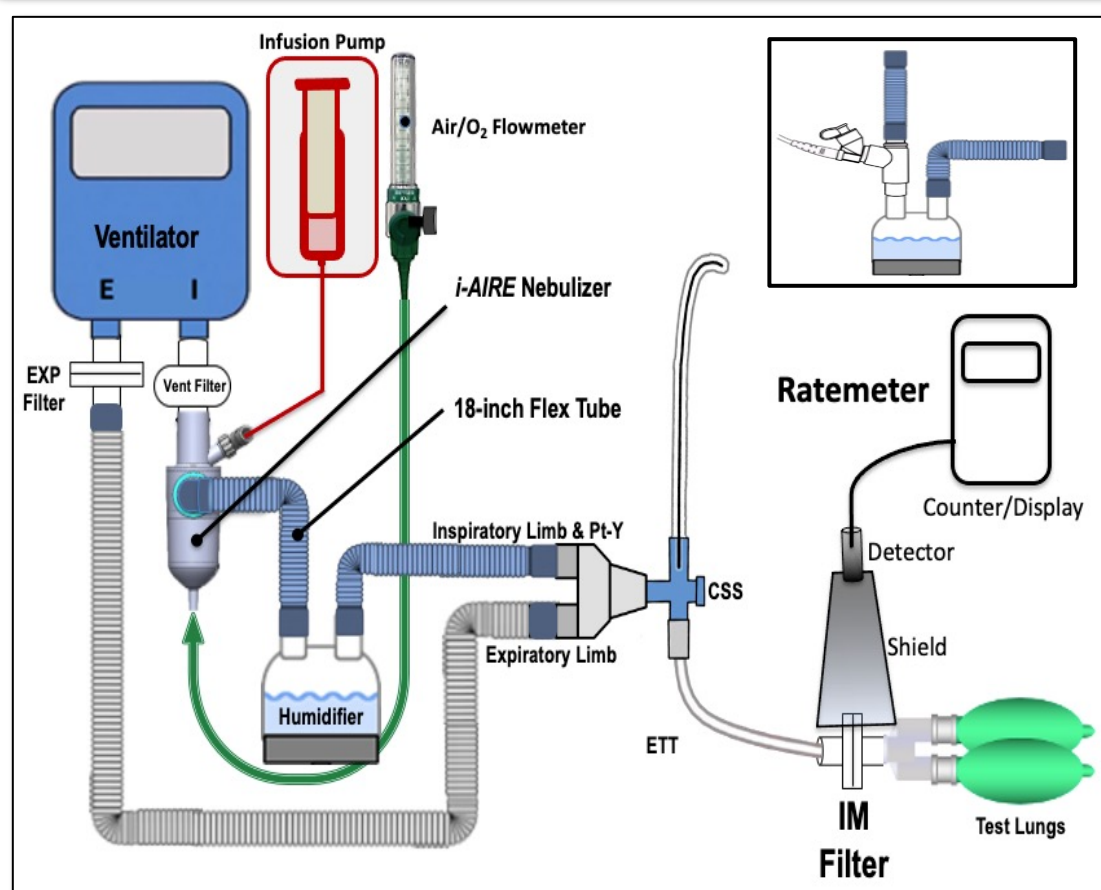
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BACKGROUND

Nebulizers on the wet/outlet side of the heated humidifier create a “heat break” resulting in excess condensation in the nebulizer and inspiratory limb, risking circuit occlusion. Dry/inlet side placement eliminates the heat break and avoids excess condensation. This study compared dry side aerosol delivery (Inhaled Mass, IM) of a prototype inline breath-enhanced jet nebulizer (BEJN) *versus* a vibrating mesh nebulizer (VMN) using real-time measurement of nebulized radioaerosol.*



TEST SETUP & METHODS



- Radiolabeled ^{99m}Tc/saline used as aerosol tracer
- Inhaled mass (IM) filter at airway opening of test lung
- Gamma ratemeter detector oriented towards IM filter to measure radioactivity accumulating on the filter
- Adult ventilator with heated wire circuit/heated humidifier;
- 2 duty cycles (DC): 0.13 & 0.34

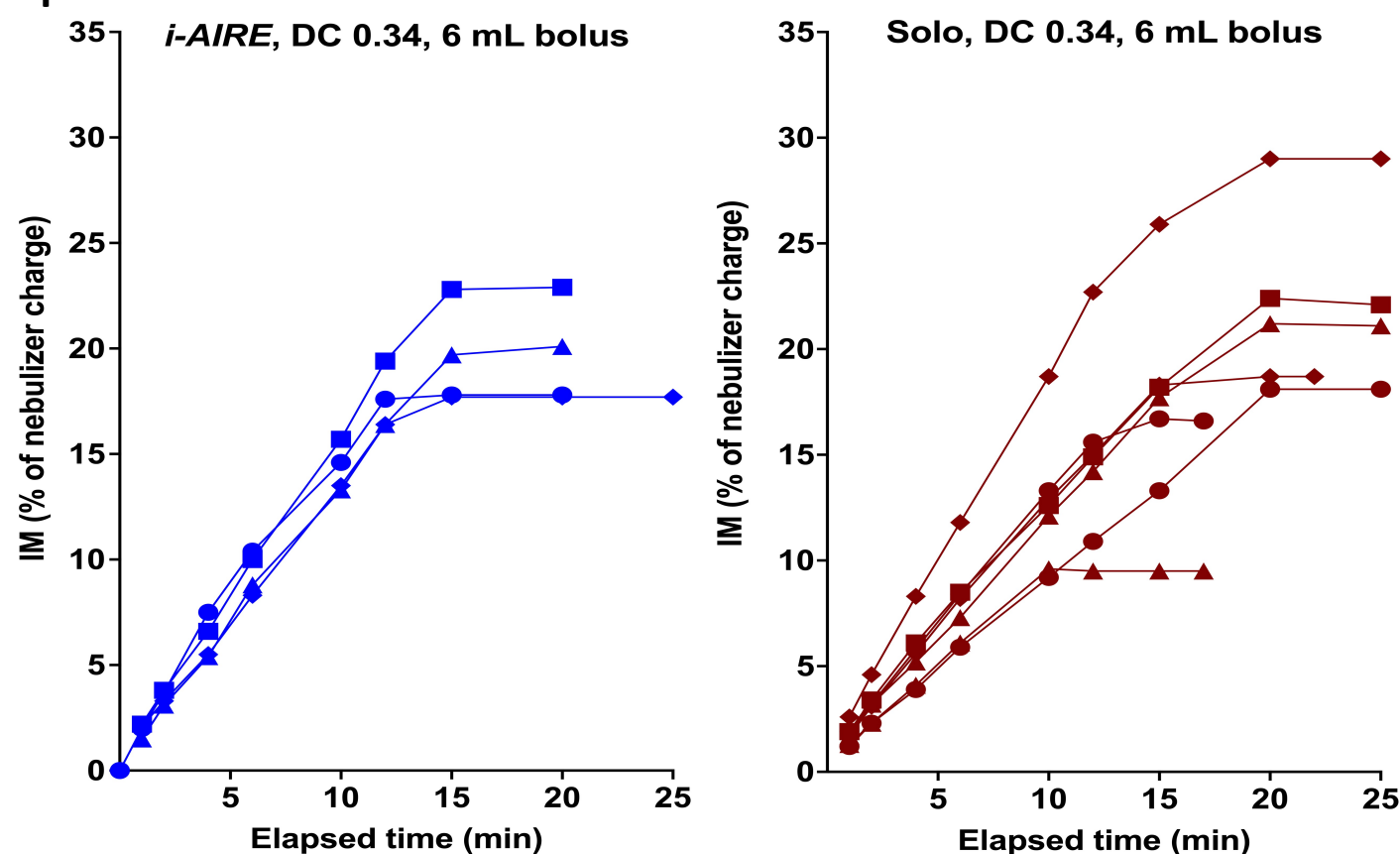
Protocol:

- InspiRx *i-AIRE* BEJN (figure) connected to inlet of humidifier
- Aerogen Solo VMN nebulizer (inset in figure) on inlet of humidifier
- Tested 3- & 6-mL bolus treatments plus continuous infusion delivery
- Infusion of neb with radiolabeled saline supplied by infusion pump
- Tested 4 sets of deliberate changes in breathing pattern and infusion flow

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RESULTS

Example bolus treatment test runs with *i-AIRE* and Solo from Table below:

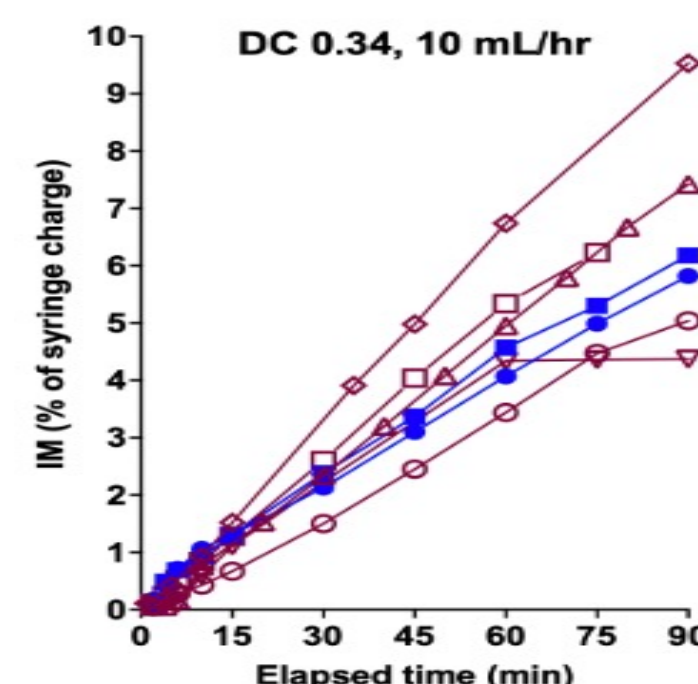


Inhaled Mass (%) During Bolus Treatment			
Neb	Duty Cycle	Bolus Volume (mL)	Mean ±SD IM (% of syringe charge)
<i>i-AIRE</i>	0.34	6	19.9 ± 4.5
		3	14.5 ± 1.7
	0.13	6	15.5 ± 4.0
		3	13.7 ± 2.5
Solo	0.34	6	19.3 ± 5.9
		3	25.5 ± 5.7
	0.13	6	13.4 ± 3.4
		3	13.6 ± 2.0

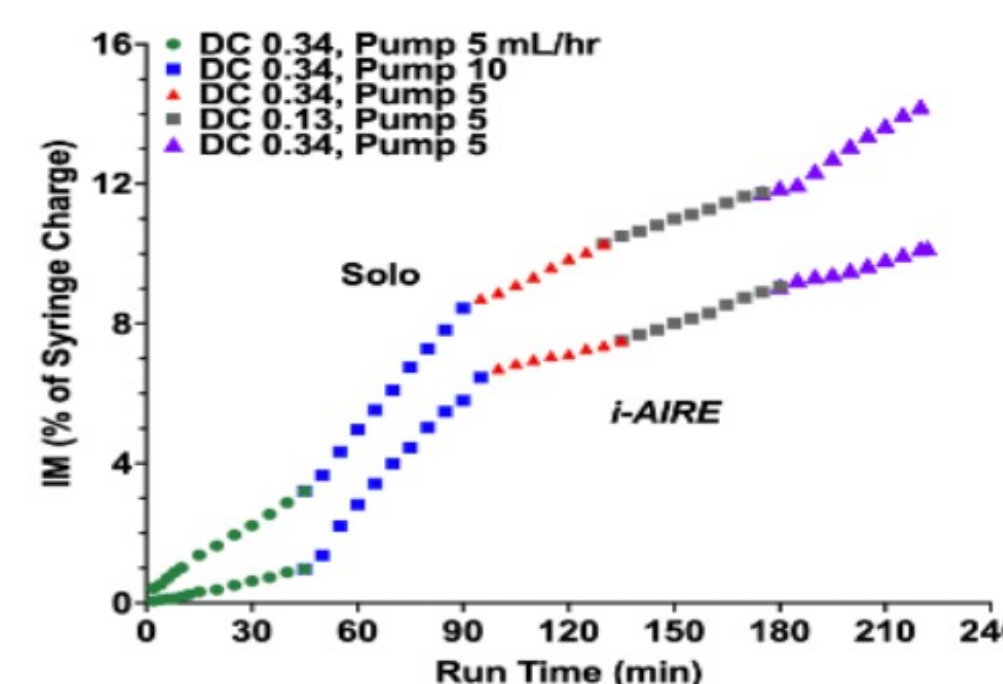
REGRESSION ANALYSIS

- IM during bolus treatment is affected by duty cycle and residual volume in the nebulizer; there was less residual in the *i-AIRE* as compared with Solo
- IM during continuous infusion is affected by duty cycle and infusion flow. IM was similar between *i-AIRE* and Solo
- During continuous infusion, adjustments made to the infusion flow, but not duty cycle, affected IM

Uninterrupted continuous infusion test runs; *i-AIRE* (blue), Solo (red):



Example of continuous infusion with changes in duty cycle and infusion flow (Set 3 in Table):



Effect on Continuous Infusion Aerosol Delivery of Changes in Duty Cycle and/or Infusion Pump Flow

Conditions	Duty Cycle	Infusion Pump Flow (mL/hr)	Rate of Aerosol Delivery (% of syringe charge/min)		
			<i>i-AIRE</i>	Solo	
Set 1	Step 1	0.34	10	0.091	0.088
	Step 2	0.13	10	0.068	0.050
	Step 3	0.34	10	0.090	0.078
	Step 4	0.34	5	0.020	0.040
	Step 5	0.34	10	0.127	0.080
Set 2	Step 1	0.13	10	0.043	0.091
	Step 2	0.13	5	0.017	0.036
	Step 3	0.13	10	0.058	0.067
	Step 4	0.34	10	0.062	0.098
	Step 5	0.13	10	0.064	0.064
Set 3	Step 1	0.34	5	0.022	0.063
	Step 2	0.34	10	0.110	0.118
	Step 3	0.34	5	0.024	0.046
	Step 4	0.13	5	0.035	0.032
	Step 5	0.34	5	0.026	0.059
Set 4	Step 1	0.13	5	0.018	0.038
	Step 2	0.34	5	0.016	0.055
	Step 3	0.13	5	0.028	0.038
	Step 4	0.13	10	0.103	0.073
	Step 5	0.13	5	0.023	0.037

CONCLUSIONS

- Aerosol delivery with nebulizer positioning on the dry side of the heated humidifier is similar for both nebulizer technologies
- BEJN is more predictable during bolus treatment
- When continuous infusion steady state is achieved, vent settings can be adjusted as usual with no significant impact on drug delivery; delivery can be predicted based on pump flow