

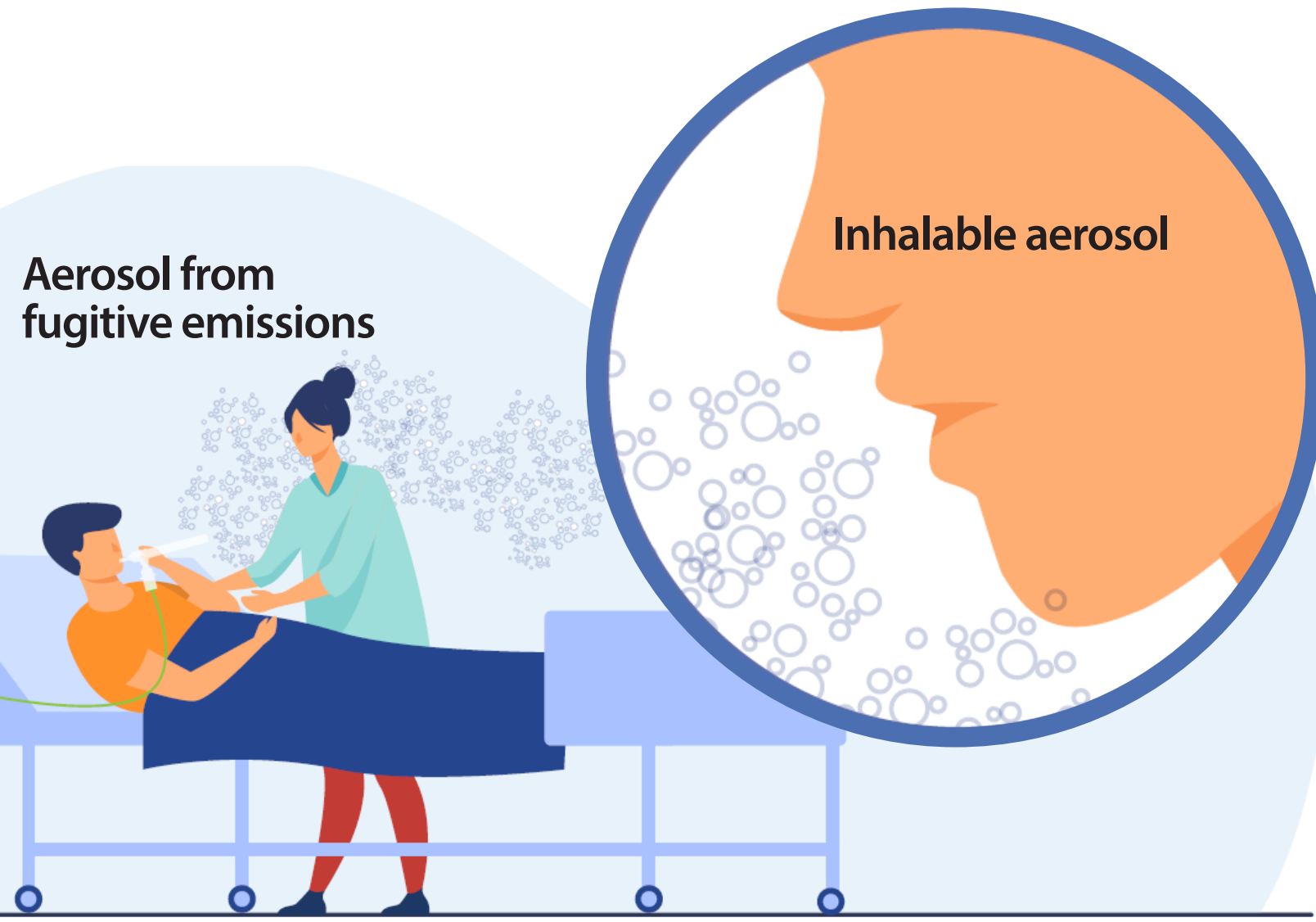
A Laboratory-Based Examination of the Potential for Fugitive Emission of Aerosols to the Local Environment from a Range of Commercially Available Nebulizer Systems

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BACKGROUND

- An unintended consequence with inhaled medication from nebulizing systems is the potential for fugitive emission during treatment
- There exists a potential risk factor in both clinical and home care settings, particularly in the context of the present COVID-19 pandemic



PURPOSE

- Compare the potential for fugitive emission from a variety of widely encountered nebulizers during simulated adult tidal breathing

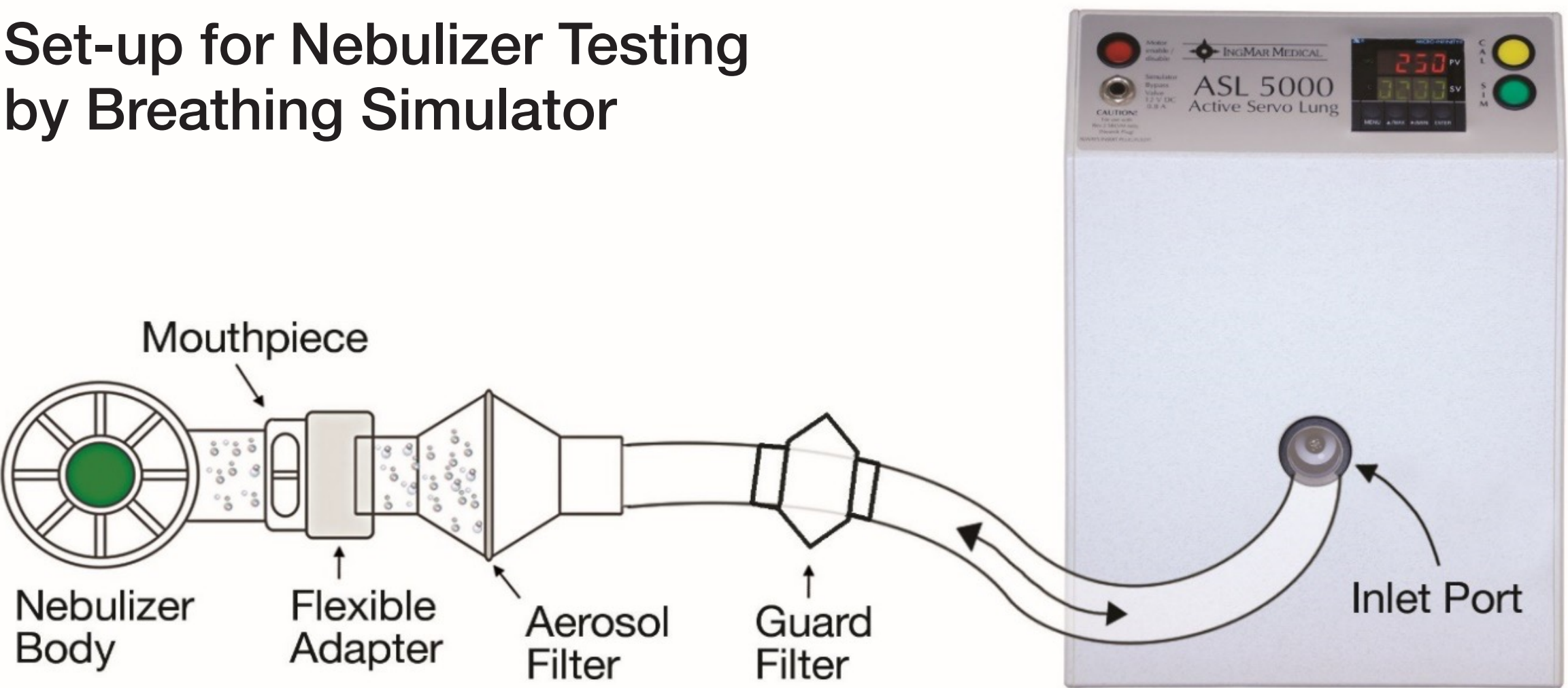
MATERIALS & METHODS

Patient Simulation

- 3 mL of albuterol (2.5 mg / 3 mL) used as the tracer aerosol
- The mouthpiece of the nebulizer-on-test was connected to an ASL 5000 (IngMar Medical), set to simulate realistic variations in inspiratory/expiratory (I:E) ratio associated with different patients' disease states

Tidal Volume (mL)	Respiration Rate (cycles/min)	I:E Ratio	Example Condition
500	15	1:1	Intervention to improve arterial oxygenation
	10	1:2	Normal adult respiration
	7	1:3	Slight/Moderate obstructive disease
	6	1:4	Severe obstructive disease

Set-up for Nebulizer Testing by Breathing Simulator



Nebulizer

- A filter was placed at the nebulizer mouthpiece and replaced after every minute of nebulization. The process repeated until sputter occurred
- 10 commonly available small volume nebulizers (SVNs) were tested — jet, breath actuated, and vibrating mesh

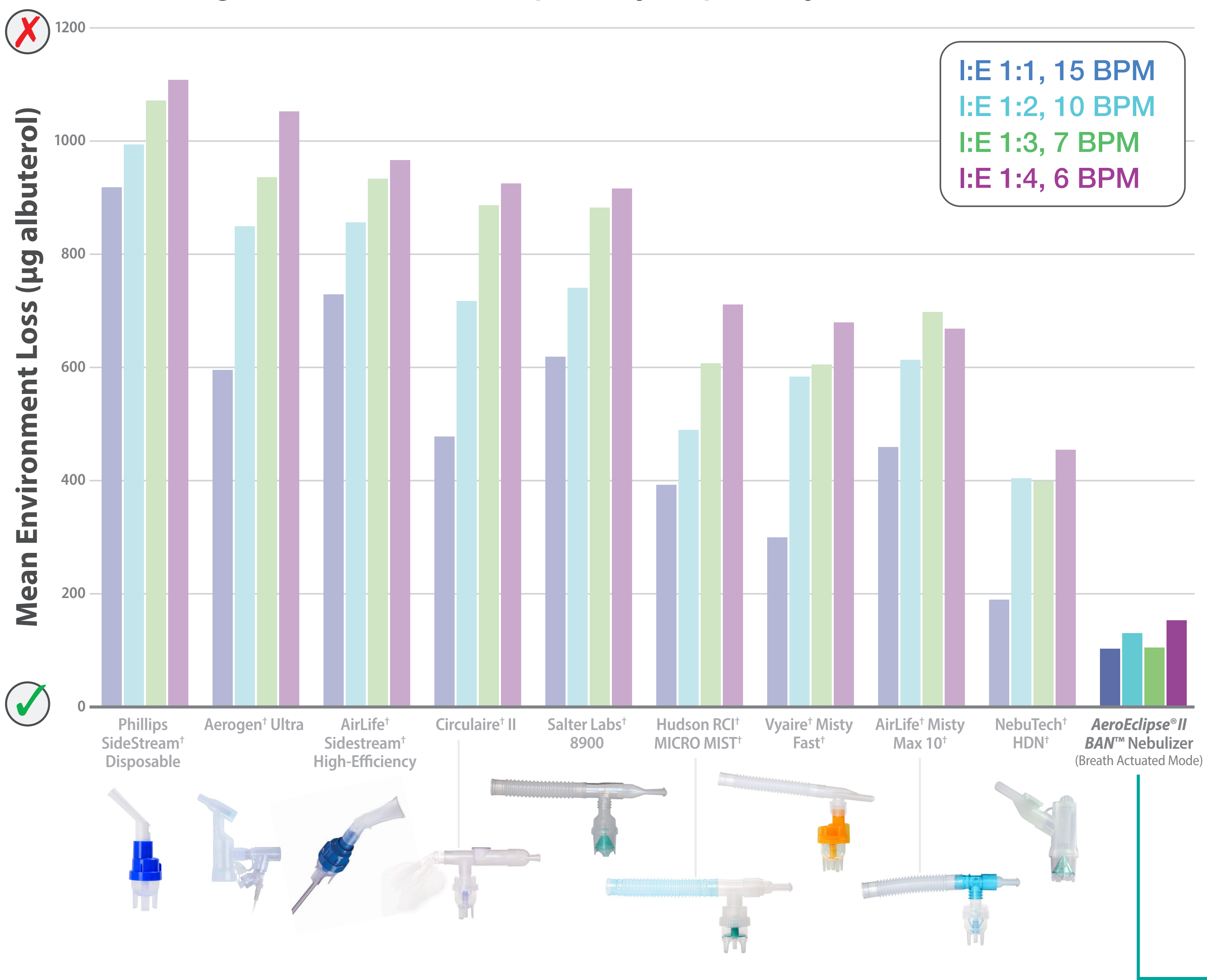
Calculated Loss:

$$L_{env} = 2500 - (M_f + M_{residual})$$

Environmental Loss of Albuterol, µg Total Mass Recovered from the Inhalation Filter Residual Mass Recovered from the Nebulizer

RESULTS

Variation of Environmental Loss of Albuterol Tracer, Showing the Influence of Inspiratory/Expiratory Ratio



- Wide variations in total dose observed with different nebulizer types (see abstract)
- Considerable variations in L_{env} across different nebulizer systems
- L_{env} was influenced by the change in I:E ratio, increasing with an increase in the length of the exhalation phase

CONCLUSIONS

Summary of Key Findings

- A wide variation in total dose across the different nebulizer types – a feature that is consistent with previous laboratory-based comparisons¹
- Growing L_{env} as a proportion of exhalation time, given that more time is proportionately available for fugitive emission generation

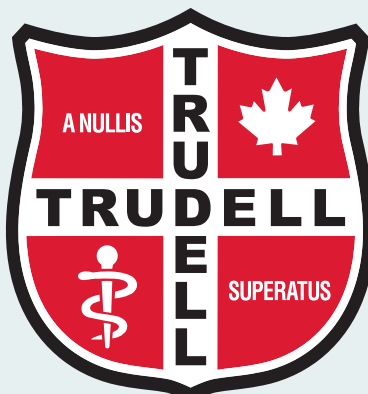
- Breath-actuation (**AeroEclipse® II BAN™** Nebulizer) substantially reduced L_{env} but did not completely eliminate it

Future Directions

- These findings could help develop policies and best practices for the risk mitigation of fugitive emissions from nebulizing systems



¹ JL Rau, A Ari, RD Restrepo: Performance Comparison of Nebulizer Designs: Constant-Output, Breath-Enhanced, and Dosimetric. Respiratory Care 2004;49(2):174-179.



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