

Aerosol delivery and Mechanical Ventilation: *In vitro* evaluation of spacers for use with a pressurized-metered dose inhaler (pMDI) and a vibrating mesh nebulizer (VMN) in comparison with T adapters.

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Introduction

Efficiency of drug delivery during mechanical ventilation is affected by many factors such as for example the type of inhalation devices [1]. Both VMNs and pMDIs can be used to administer aerosolized medication to the lungs. pMDIs are recommended to be used with spacers [2] and nebulizers are usually used with T adapters.

Objective: To evaluate *in vitro* performances of spacers in comparison with T adapters when using both a pMDI and a VMN in an adult and paediatric mechanical ventilation model.

Material and Methods

A ventilator (Evita 2 Dura, Dräger) was connected to a test lung model (SmartLung Adult, IMT Medical). An endotracheal tube (ETT) (7.5 mm ID for the adult model and 4.5 mm ID for the paediatric model) and a right-angle elbow adapter were inserted between the Y-piece and the ETT. Delivered dose was collected on a filter inserted between the ETT and the test lung model. Spacers and T adapters were inserted into the inspiratory limb excepted Aerochamber Mini[®] inserted after the Y piece as recommended by the manufacturer.

Two different series of measurements were performed:

- **With a pMDI:** 10 doses containing 100 µg of salbutamol were actuated in the inhaler devices during inspiratory phases.

- **With a VMN:** A solution containing 5 mg of salbutamol (2.5 mg/2.5 mL) was nebulized with the VMN Aeroneb Solo[®] (Aerogen).

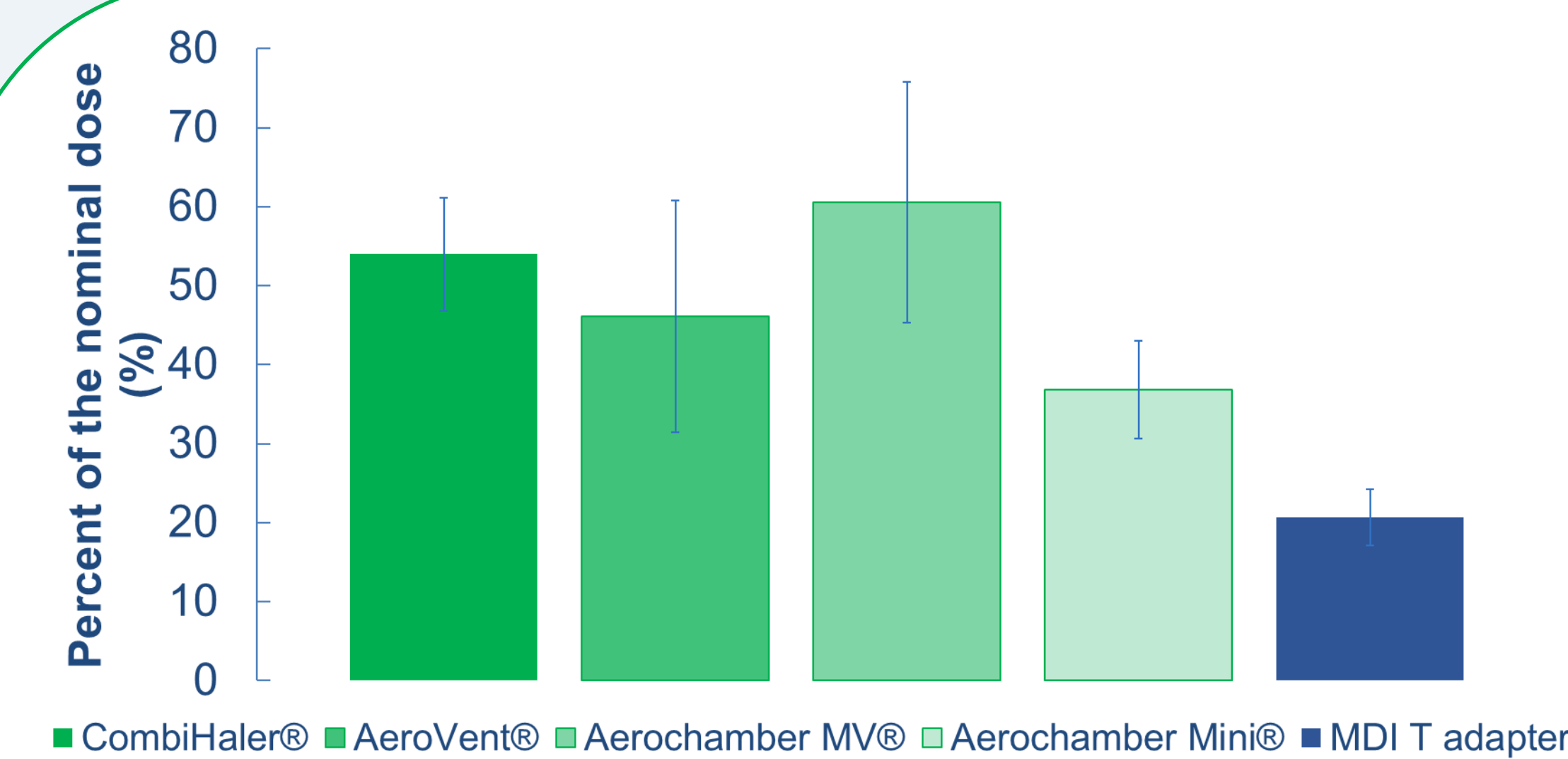
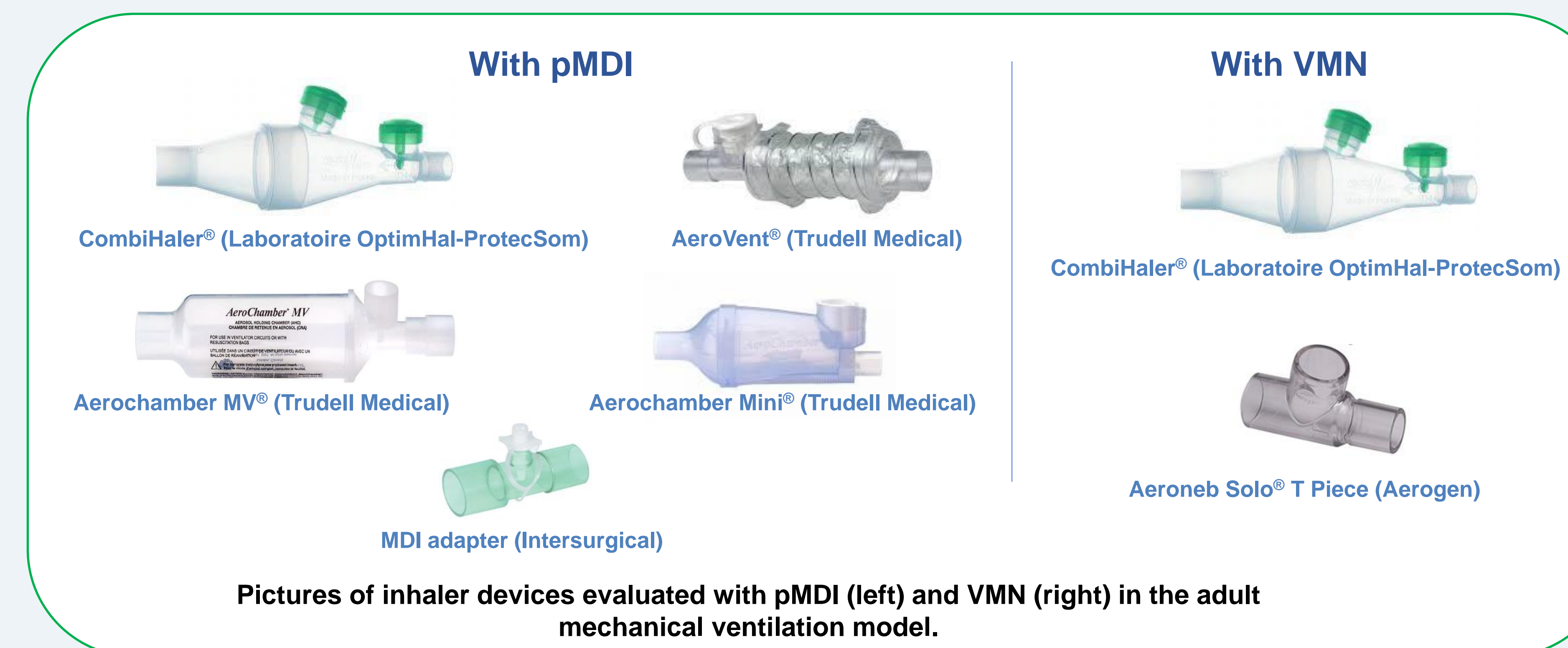
Measurements were performed with adult settings (tidal volume 450 mL, frequency 15 min⁻¹, Positive End Expiratory Pressure (PEEP) 5 cmH₂O, ratio between inspiratory and expiratory 1/2) and paediatric settings which correspond to a child of 15 kg weight (tidal volume 150 mL, frequency 25 min⁻¹, PEEP 5 cmH₂O, ratio between inspiratory and expiratory 1/1). Each component of the circuit was recovered with a NaCl solution (0.1 M) and quantified by UV spectrophotometry at 225 nm. Statistical analyses were performed using GraphPad Prism 6.01 (GraphPad software, CA) and consisted of t-tests. A p value < 0.05 was considered as significant.

Bibliography

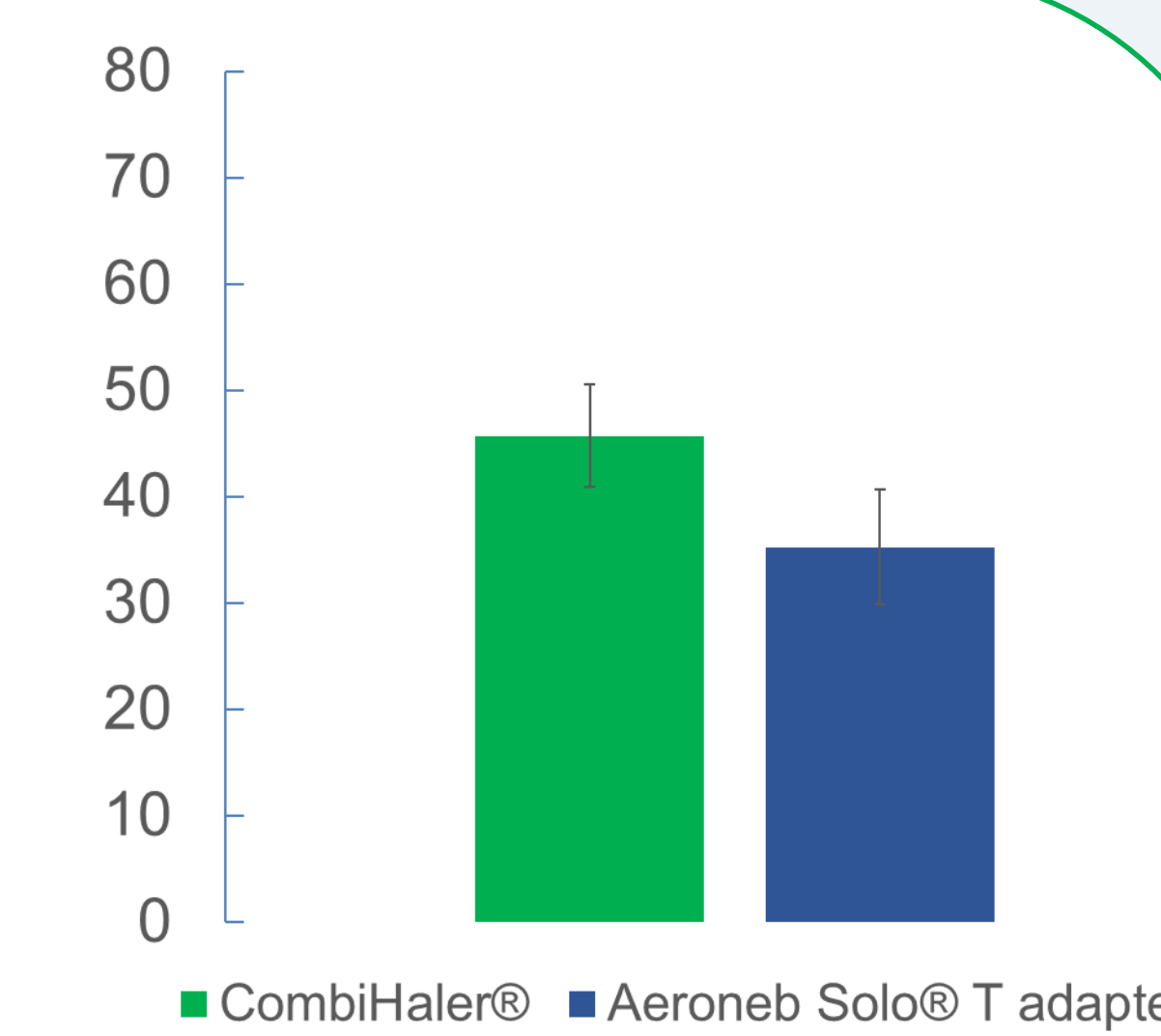
1. Ari A, Aerabi H, Fink JB: Evaluation of Aerosol Generator Devices at 3 Locations in Humidified and non-humidified Circuits During Adult Mechanical Ventilation, *Respir Care* 2010, 55: 837-844.
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Results

Adult model



Aerosol delivery obtained with the four spacers in comparison to the T adapter using a pMDI.

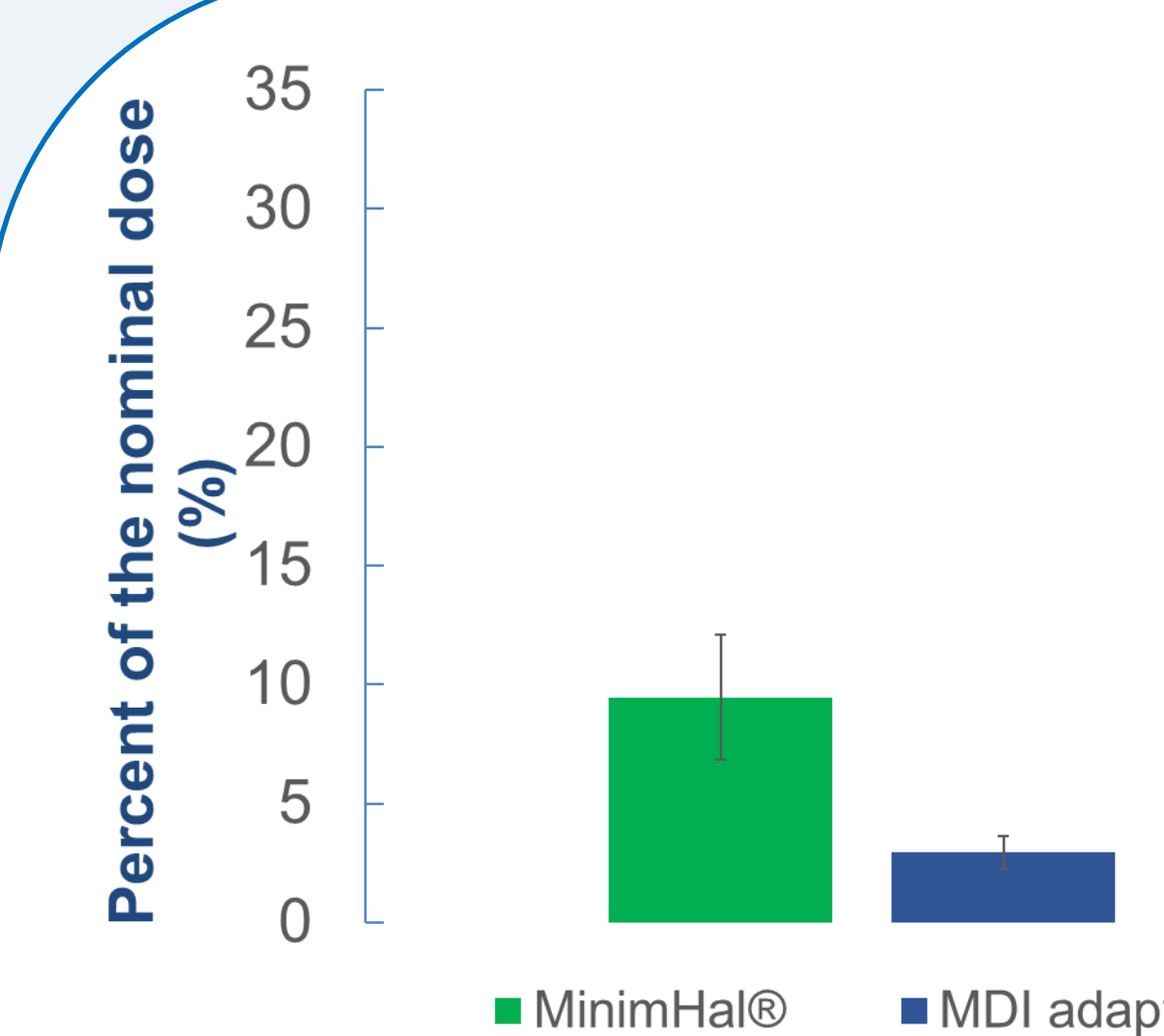
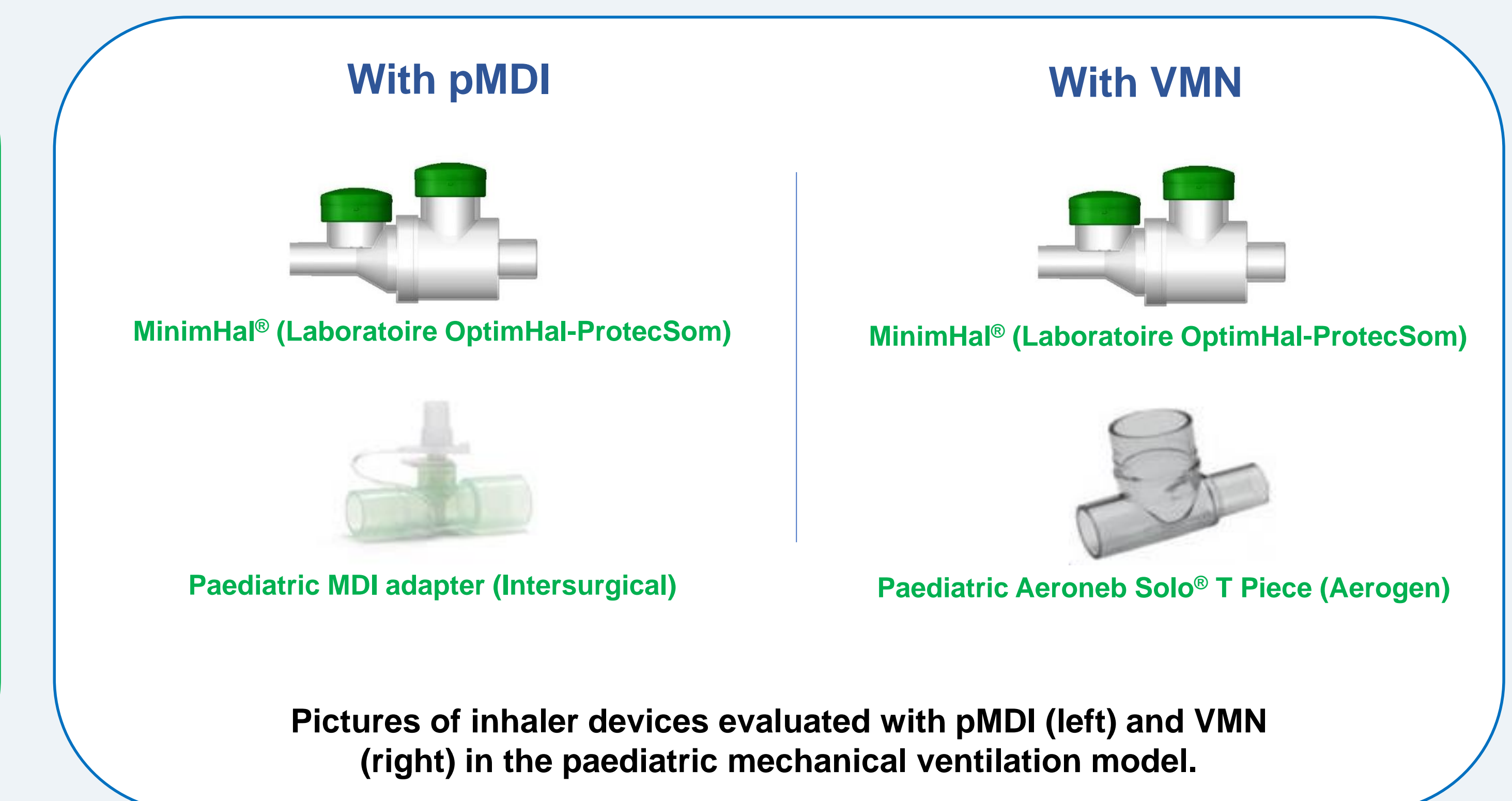


Aerosol delivery obtained with the spacer in comparison to the T adapter using a VMN.

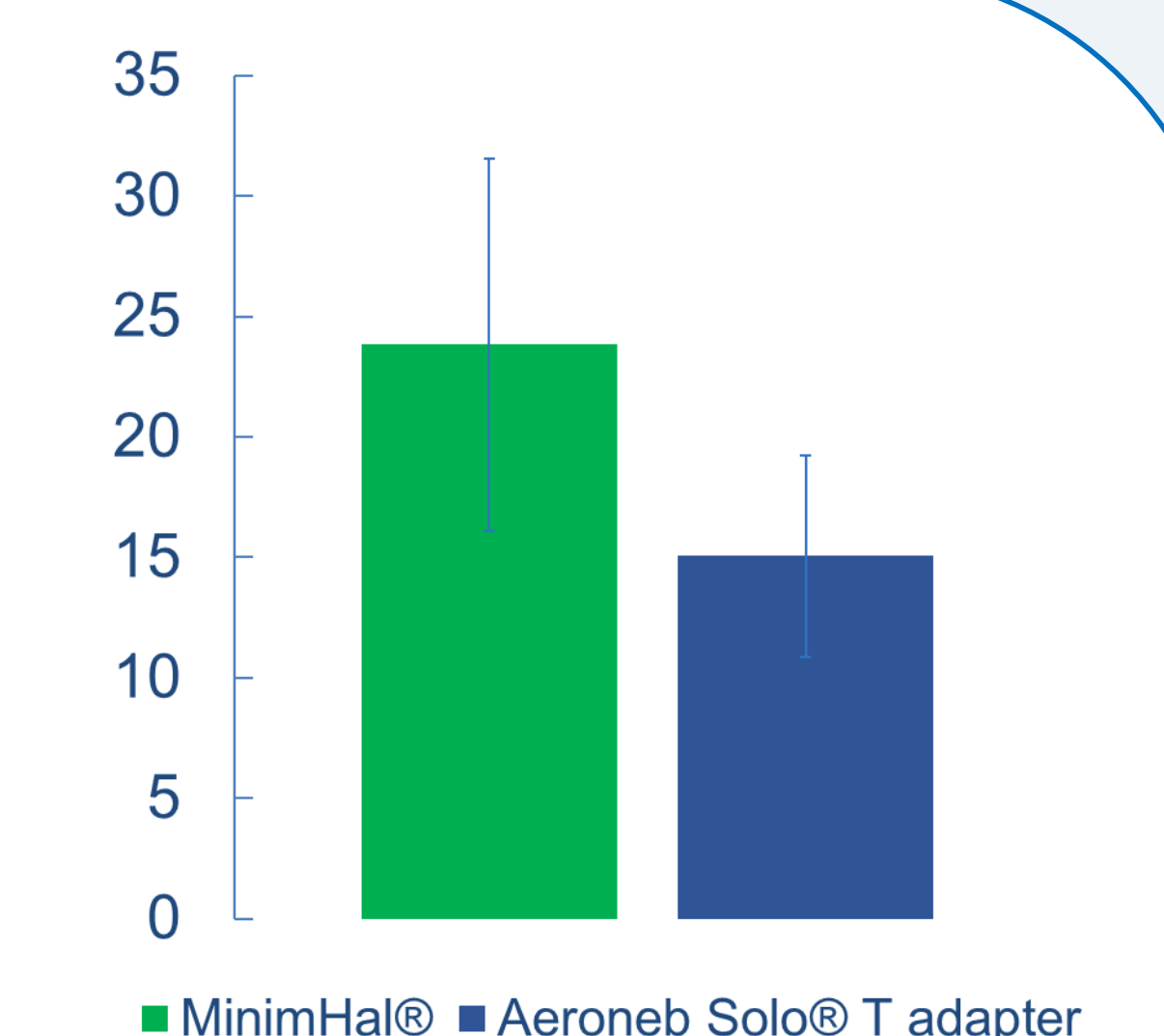
	CombiHaler [®]	AeroVent [®]	Aerochamber MV [®]	Aerochamber Mini [®]	MDI T adapter
Percent of the nominal dose (%)	53.96 ± 7.14	46.15 ± 14.67	60.49 ± 15.24	36.06 ± 6.17	20.68 ± 3.64

	CombiHaler [®]	Aeroneb Solo [®] T adapter
Percent of the nominal dose (%)	45.72 ± 4.48	35.26 ± 7.44

Paediatric model



Aerosol delivery obtained with the spacer in comparison to the T adapter using a pMDI (right) and a VMN (left).



	MinimHal [®]	MDI T adapter
Percent of the nominal dose (%)	9.45 ± 2.27	2.94 ± 0.34

	CombiHaler [®]	Aeroneb Solo [®] T adapter
Percent of the nominal dose (%)	23.84 ± 7.27	15.06 ± 4.18

Conclusions

Results show that aerosol delivery with pMDI and VMN is higher when using a spacer in comparison with a T adapter for both adult and paediatric mechanical ventilation models ($p < 0.05$) and are consistent with previous studies. These results could be explained by the larger spacer internal volume decreasing the particles' impactation within devices compared to T adapters.