

# In vitro evaluation of spacers in comparison with T-adapters in mechanical ventilation with pMDI and vibrating mesh nebulizer.

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## Introduction

The efficiency of drug delivery in mechanical ventilation depends on multiple factors as for example the type of inhalation devices [1]. Either vibrating mesh nebulizers and pressurized metered dose inhalers (pMDI) can be used to administer aerosols drugs. The pMDI is recommended to be used with a spacer [2] and the nebulizer is usually used with a T-adaptor. The aim of this study is to evaluate the performance of spacers as compared to T-adapters when using with both a pMDI and a vibrating mesh nebulizer.

## Methods

A ventilator (Evita 2 Dura, Dräger) was used in volume-controlled mode connected to the test lung model (SmartLung Adult, IMT Medical). Measurements were performed with adult settings (Tidal volume = 450 mL, frequency = 15 cycles/min, Positive End Expiratory Pressure (PEEP) = 5 cmH<sub>2</sub>O, ratio between inspiratory and expiratory time = 1/2 and a flow rate of 21 L/min) An endotracheal tube (ETT) (7.5 mm internal diameter) and a right-angle elbow adapter were inserted between the Y-piece and the test lung model (figure 1). The delivered dose was collected on a filter inserted between the ETT and the test lung model. The inhaler devices were inserted in the inspiratory limb, just before the Y piece.

Two different measurements were performed ;

- **Use with a pMDI** : 10 doses containing 100 µg of Salbutamol (Ventolin® 100 µg, GlaxoSmithKline) were actuated in the prototypes during inspiration.

- **Use with a vibrating mesh nebulizer (VMN)** : A solution containing 5 mg of Salbutamol (Salbutamol Mylan, 2.5 mg/2.5 mL) was nebulized with the vibrating mesh nebulizer Aeroneb® Solo (Aerogen).

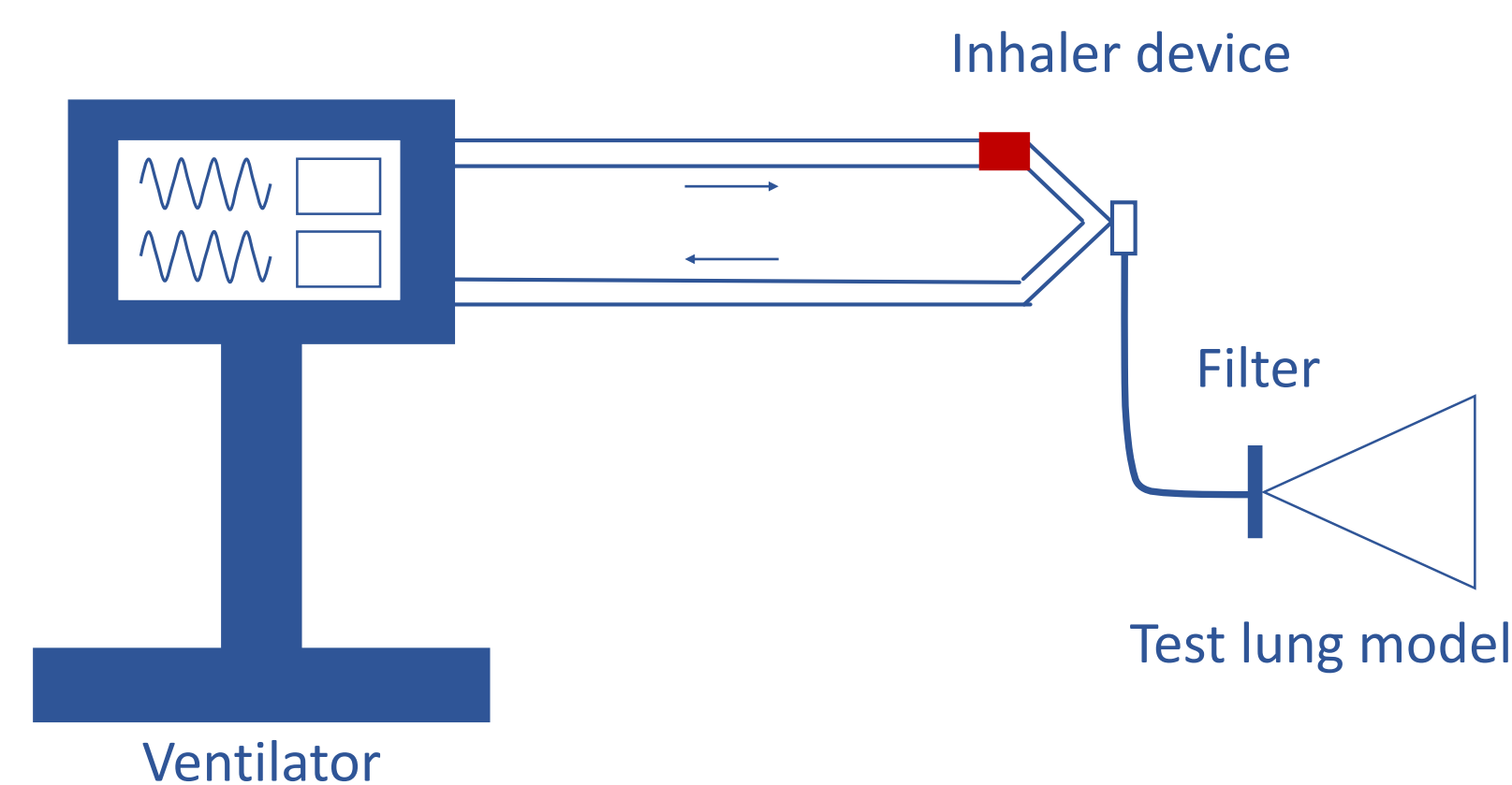


Figure 1: Schematic drawing of the bench model used for the experiments.

The filter and each component of the mechanical ventilation circuit were recovered with a NaCl solution (0.1M) and quantified by UV spectrophotometry. Each measurement was performed five times. Results are expressed as means ± standard deviations. Statistical analyses were performed using GraphPad Prism 6.01 (GraphPad Software, CA) and consisted of multiple t-tests. A p-value < 0.05 was considered significant.

## Materials

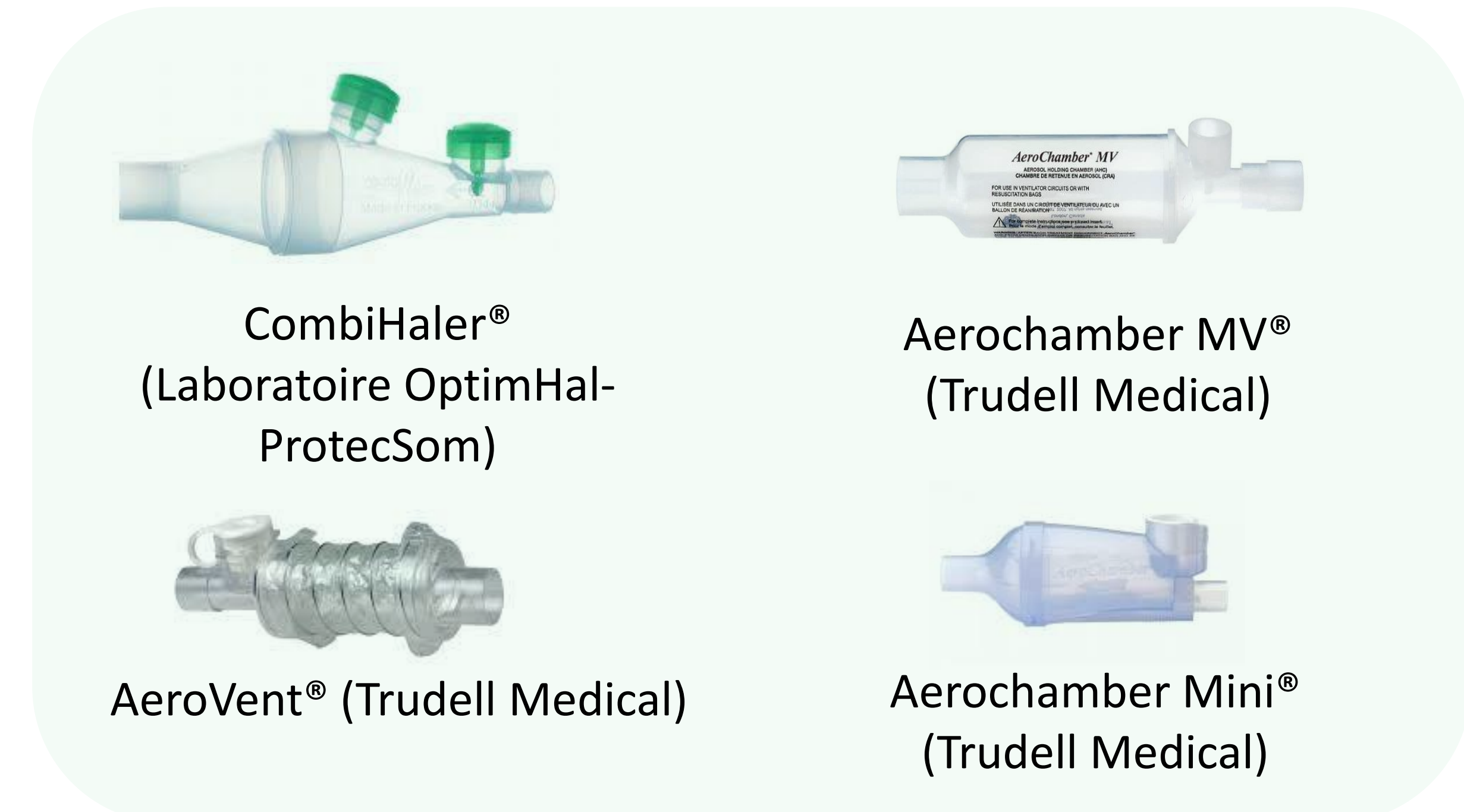


Figure 2: Pictures of inhaler devices evaluated with the pMDI.

## Use with a pMDI



## Use with a vibrating mesh nebulizer (VMN)



Figure 3: Pictures of inhaler devices evaluated with the VMN.

## Aerosol delivery

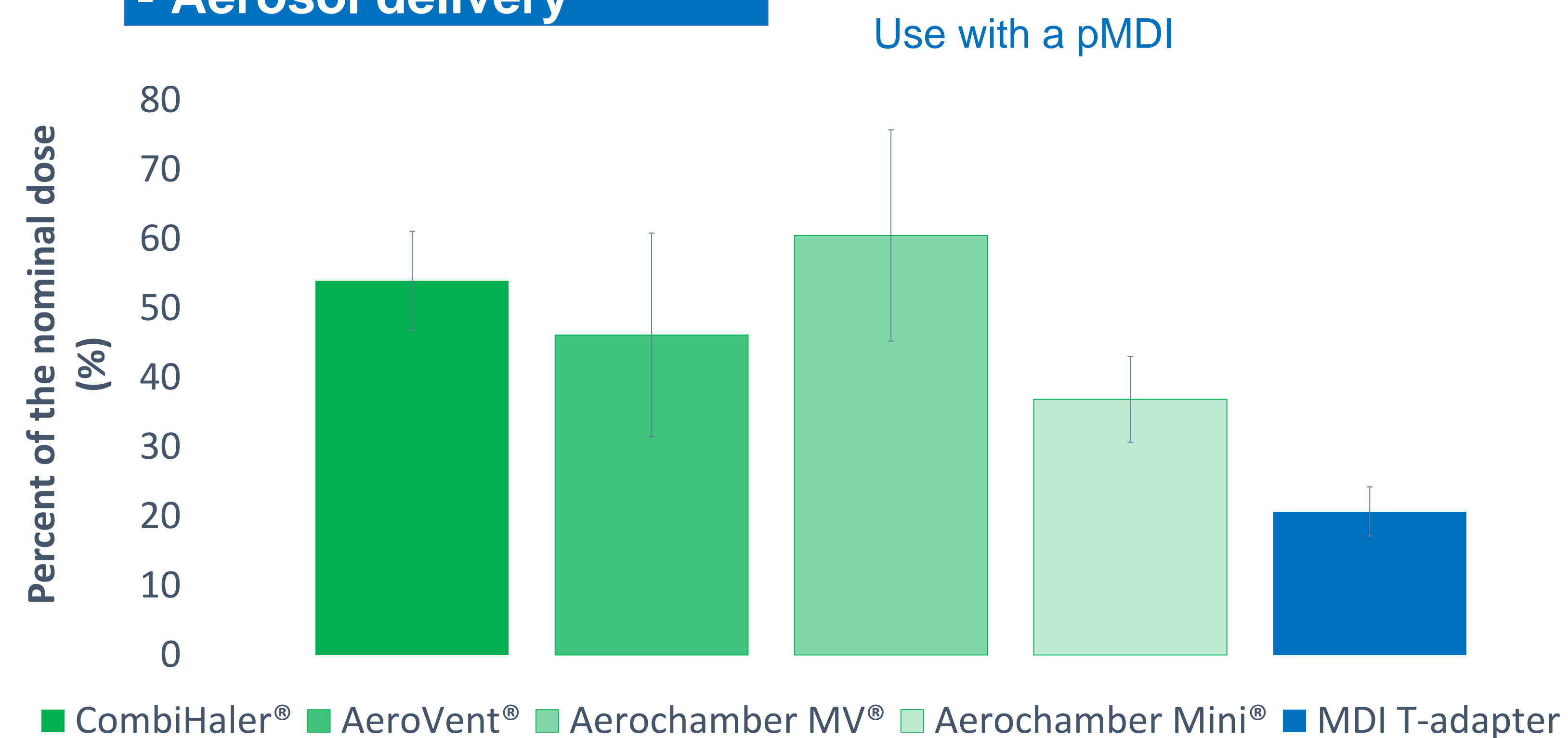


Figure 4 and table 1: Aerosol delivery obtained for the four spacers in comparison to the T-adaptor when using a pMDI.

	CombiHaler®	AeroVent®	Aerochamber MV®	Aerochamber Mini®	MDI T-adaptor
Percent of the nominal dose (%)	53.96 ± 7.14	46.15 ± 14.67	60.49 ± 15.24	36.86 ± 6.17	20.68 ± 3.64

## Use with a vibrating mesh nebulizer (VMN)

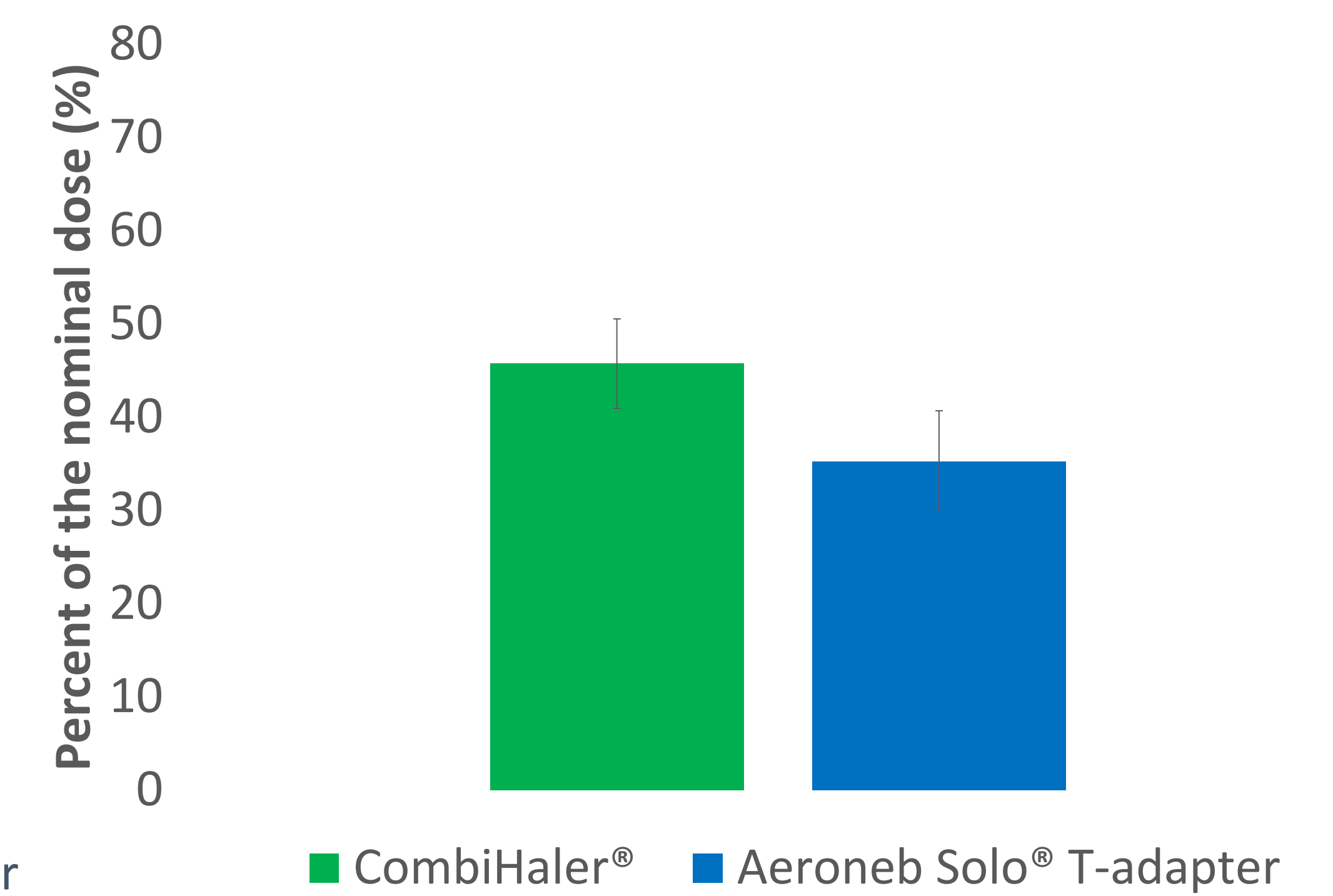


Figure 5 and table 2: Aerosol delivery obtained for the spacer in comparison to the T-adaptor when using a VMN.

	CombiHaler®	Aeroneb Solo® T-adaptor
Percent of the nominal dose (%)	45.72 ± 4.48	35.26 ± 7.44

## Conclusion

The results show that the *in vitro* aerosol delivery with the spacers is higher than aerosol delivery obtained with the T-adapters when using both a pMDI and a vibrating mesh nebulizer ( $p < 0.05$ ) and are consistent with previous studies. The CombiHaler® spacer has higher or similar performances than others spacers and can be used with both a pMDI and a VMN.

## References

- [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.  
[2]: Boukhattala N, Porée T, Diot P, Vecellio L: In vitro Performance of Spacers for Aerosol Delivery during Adult Mechanical Ventilation, *Journal of Aerosol Medicine and Pulmonary Drug Delivery* 2014, 27.



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