

**Inhalation Chamber in Neonatology:
Benefit of a Device Without Dead
Space and Facemask Holding Duration
for Optimal Corticosteroid Inhalation**

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Disclosures

**All authors are
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Background

Previous studies have evaluated aerosol delivery with a pressurized metered dose inhaler (pMDI) and a valved holding chamber (VHC) **on neonates and infants**. They **have shown a very low lung deposition**^{1,2}. This could be due to:

- The **dead space** which is higher than the tidal volume of neonatal patients.
- The inability of very young children to open the **inspiratory valve**^{3,4,5}.

Dead space is the volume between the patient and the inspiratory valve. It could be suppressed by removing the valve.

Furthermore, holding an inhalation mask on a neonatal patient is difficult and could result to the patient's stress and cry. For these reasons, knowing the **minimal facemask holding duration for optimal drug delivery** could be really helpful to optimize drug delivery and patient's comfort.

This *in vitro* study aims to show the benefit of using an inhalation chamber without dead space by removing the inspiratory valve and to evaluate the effect of facemask holding duration on *in vitro* drug delivery.

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[3]: Herbes C, Goncalves AM, Cantori Motta G, Aparecida Dos Santo Ventura D, Colvero M, Amantea SL, Metered Dose inhaler Therapy with Spacers : Are newborns capable of using this system correctly? (2019) *Paediatric Pulmonology*, 54:1417-1421.

[4]: Reginato R, Amantea SL, Krumenauer R, Pressure gradient and inspiratory times required for valve opening of various holding chamber (2011), *Allergy and asthma proceedings*, 32: 137-141.

[5]: Fok TF, Lam K, Chan CK, Cheung P, Zhuang H, Wong W, Cheung KL, Aerosol delivery to Non-ventilated infants by metered dose inhaler: should a valved spacer be used? (1997), *Paediatric Pulmonology*, 24: 204-212.

Materials and Methods



Figure 1: Picture of inhalation chamber prototype.

Prototypes consisted in:

- ✓ TipsHaler® (Laboratoire OptimHal- ProtecSom) **with and without the inspiratory valve.**
- ✓ A prototype of facemask with the opening centred between the nose and the mouth, which is hypothesized to be more suitable for neonates than traditional facemask with the opening centred on the mouth, because neonates are nasal breathers⁵.

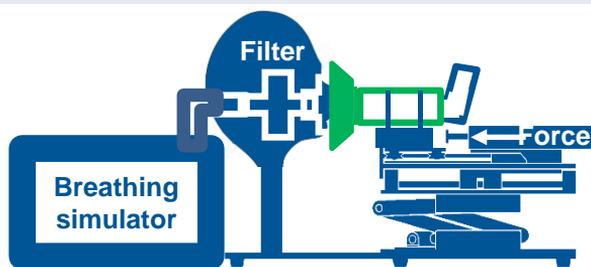


Figure 2: Diagram of the experimental set-up.

Neonate breathing pattern was simulated by a breathing simulator (BRS2000, Copley). Measurements allowed to assess the emitted mass for uncoordinated actuation with inhalation.

- **Breathing parameters** used are tidal volume 24.7 mL, frequency 52 breaths/min, inspiratory time/total time ratio 0.47)⁶.
- Spacers with facemask were applied to an infant face model (Copley) with **0.8 kg force**.
- **Five pMDI doses** (Beclomethasone, 100 µg/dose) were administered with 1 minute interval.
- Drug deposited was collected on a filter and quantified by UV spectrophotometry.
- Statistical analyses were performed using t-tests (** p<0.01, *p<0.05).

Facemask was held during 2 to 40 breathing cycles.

Measurements were performed with and without the inspiratory valve.

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Results

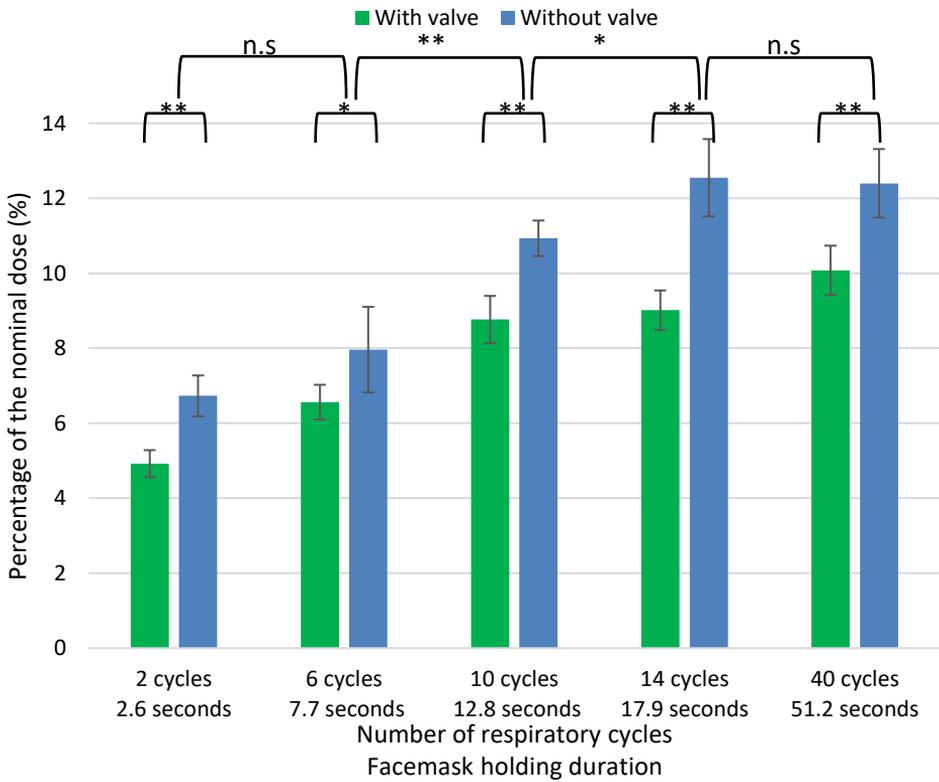


Figure 3: Percentage of the nominal dose recovered on the filter (%) for the inhalation chambers with or without inspiratory valve as a function of the number of breathing cycles and facemask holding duration after pMDI dose administration. Results are expressed as means \pm standard deviations.

- The dose of drug recovered on the filter was significantly higher with the prototype without inspiratory valve than with inspiratory valve.
- The recovered dose increased with a longer duration of mask holding up to 14 cycles. The recovered doses after 14 (17.9 seconds) and 40 cycles (51.2 seconds) were not statistically different.
- The highest dose of drug recovered was 12.39 ± 0.92 % for 14 cycles without inspiratory valve, which represents 17.9 seconds of mask holding.

Conclusions

According to this *in vitro* study, it seems **beneficial to use the inhalation chamber TipsHaler® without inspiratory valve** for newborns. Holding the mask on the face **18 seconds** after aerosolized drug administration seems to be sufficient for an optimal deposition when actuation is not synchronized with inhalation.

Measurements with actuation synchronized with inhalation remains to be performed. Moreover, it seems interesting to study until which age is it necessary to add an inspiratory valve.

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