

# Valved Holding Chamber (VHC) Facemasks – Material and Design Contributors to Delivery Performance and Hygiene

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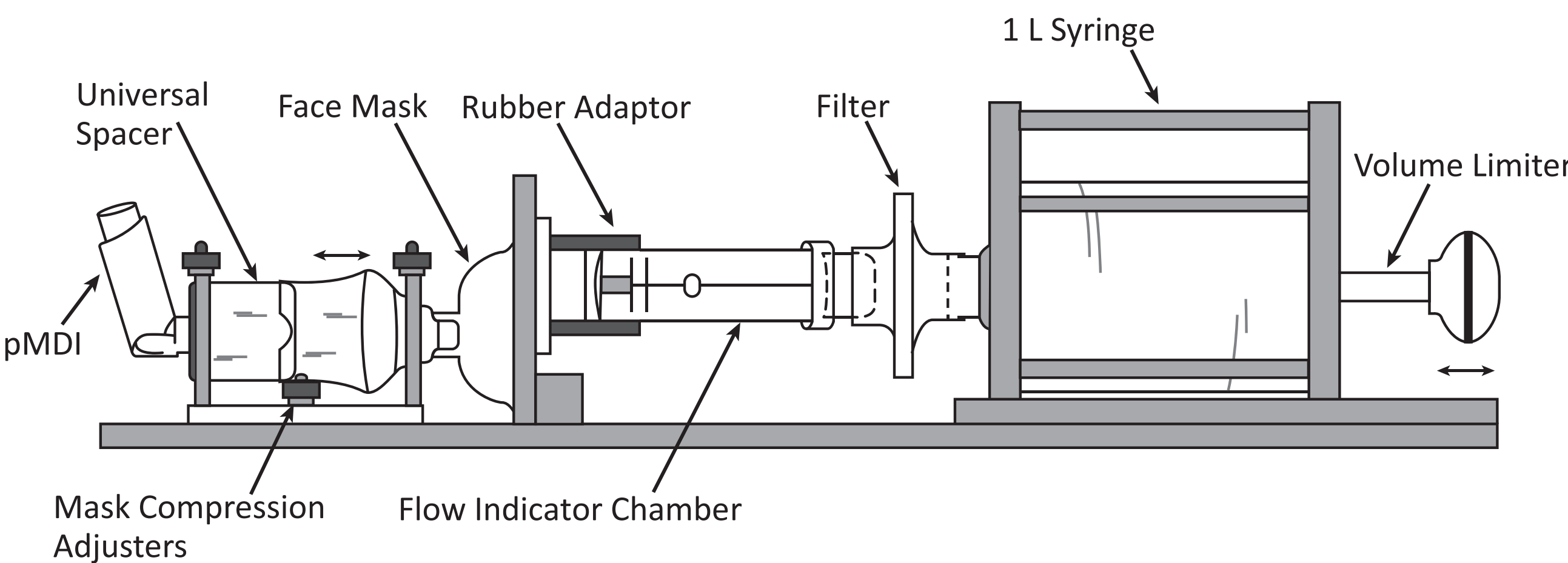
## Introduction

- VHC plus facemask: an established device combination that improves patient drug delivery.
- Device hygiene remains necessary to counter electrostatic charge and drug residue.<sup>1</sup>
- Potential for pulmonary disease secondary to use:
  - ◆ microbial contamination of VHCs<sup>2</sup>
  - ◆ nasopharyngeal microbial shedding and/or microbes drawn in from the VHC
  - ◆ contamination enhanced by moist breath and drug residue ‘nutrients’.<sup>3</sup>
- Until now, research has mainly focused on the VHC body.

## Research Objective

- A comfortable facemask that encourages VHC use.
- An alternative to flexible, stable but highly pro-static silicone.
- **To investigate the effect of facemask polymer type and electrostatic charge on drug dose.**

Figure 1 - Tidal breathing simulation apparatus



## Polymer

- classic PVC polymer not used owing to presence of additives not universally permissible in paediatrics.
- a new PVC derivative development-polymer with anti-static properties plus anti-microbial inorganic metal ion additive.

## Results

- new polymer maintained good anti-static properties (Figure 2).



Figure 2 - Polystyrene ball test: silicone polymer (L) and new development polymer (R)

## Discussion

- the static visualization indicates a silicone facemask would affect drug delivery if drug particles behave per polystyrene balls.
- AeroChamber facemask drug deposition would be  $\sim 4.5\mu\text{g}$  ( $3.09\mu\text{g} \times 1.45$ ) if drug recovery is a surface area effect.
- cuff design very likely contributed to drug retention.
- the new polymer markedly reduced facemask drug retention, as demonstrated when surface area was the same.

## Conclusions

- facemask polymer can affect dose with tidal breathing.
- facemask geometry and surface area may also contribute to drug retention.
- microbial material could be retained within the cuff.
- these findings should be investigated further, particularly given humid tidal breathing

## Notes:

1. microbial and drug particles are similar diameter: both are present on facemasks.<sup>2</sup>
2. cuff design is *not* unique to AeroChamber facemask.
3. most UK prescribed facemasks *do* have a cuffed shape.

## Methods

### Electrostatic charge

- reproducible measurement of static is variable and difficult.
- static attraction of polystyrene balls used as a simple non-scientific visualization.

### Paediatric tidal breathing simulation

- experimental apparatus (Figure 1) — tidal breathing of 2 to 7 year-olds.<sup>4</sup>
- two breaths simulated through the apparatus (1L air syringe: 30L/min flow and 180mL vol).
- salbutamol sulphate (Ventolin® HFA) shunted back and forth via the facemask, between VHC and flow chamber.
- drug recovery ( $\mu\text{g}$ ): emitted active +/- actuator, facemask, and filter.
- facemask assessments, with internal surface area determined:
  - ◆ AeroChamber VHC + standard silicone facemask } inward-facing cuff design
  - ◆ A2A Spacer + standard silicone facemask } no cuff, identical geometry
  - ◆ A2A Spacer + new polymer facemask }

- new polymer attracted 4-7% of the drug residue collected from the other two masks under breathing simulation (Table 1).

| VHC + facemas material (n=5) |                        | face mask cuff | facemask salbutamol sulphate per actuation, $\mu\text{g}$ (mean $\pm$ SD) | facemask surface area ( $\text{mm}^2$ ) |
|------------------------------|------------------------|----------------|---------------------------------------------------------------------------|-----------------------------------------|
| A                            | AeroChamber + silicone | Yes            | $5.65 \pm 1.48$                                                           | 10483                                   |
| B                            | A2A + silicone         | No             | $3.09 \pm 0.72$                                                           | 7235                                    |
| C                            | A2A + new polymer      | No             | $0.22 \pm 0.14$                                                           | 7235                                    |
| A : C and B : C              |                        |                | 100:4 and 100:7                                                           | 1.45:1 and 1:1                          |

Table 1 - Salbutamol sulphate facemask deposition

## References

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