

Mark Sanders¹, Ronald Bruin¹, and Cuong Tran².

¹ Clement Clarke International Ltd., Edinburgh Way, Harlow, CM20 2TT, UK.

² i2c Pharmaceutical Services, Cardiff Medicentre, Heath Park, Cardiff, CF14 4UJ, UK.

- Young users of pressurised metered dose inhalers (pMDIs) **require a face mask** to use the accompanying valved holding chamber (VHC) to best effect.¹
- VHC-bodies are often made of anti-static materials whereas currently a **silicone polymer is a preferred material for the face mask**; for material stability, 'fit' and comfort.
- Silicone is, however, **highly pro-static**, and drug particles readily attach to electrostatically charged surfaces.
- Young users of VHC plus face mask devices adopt a **tidal breathing technique** which may further **enhance mask drug retention** by increasing exposure to the mask material.
- **Alternative polymers** (highly static-resistant, polyvinyl chloride-based) have been considered but some of these contain bisphenol A (BPA), latex or phthalates that **diminish their desirability**.
- Clement Clarke has identified a new polymer that is comfortable, easy to clean, free from BPA, latex and phthalates, and has good antimicrobial properties as well as **good anti-static properties**.

- Previous studies have shown that different silicone face masks of identical geometry affect delivered dose². In the present study, we determine the *in vitro* dose depletion by silicone and non-silicone polymer valved holding chamber (VHC) face masks.



Initial assessment

- Reproducible measurements of static charge are notoriously difficult to achieve.
- A simple concept illustration was developed in house that provided indicative results using small polystyrene balls which exhibit high affinity for electrostatic charge.

Main investigation

- An experimental apparatus was constructed in house to simulate the tidal breathing of young VHC users, using the 2 to 7 year-old breathing pattern work of Schultz et al.³ (Figure 1)
- The mechanical rig was designed to permit an aerosol dose to be shunted forwards and backwards past the mask between the VHC and a holding chamber.
- Clement Clarke International and i2c Pharmaceutical Services worked together to measure the amount of the exemplar drug salbutamol sulphate (Ventolin® HFA pMDI, GSK) recovered from three face masks after two tidal breaths:
 - AeroChamber® VHC with silicone face mask, and
 - A2A Spacer® with either a silicone or a new polymer face mask, both of identical geometry.
- No statistical analysis has been carried out.

Initial assessment

- The silicone mask (**left, in Figure 2**) typically attracted many more polystyrene balls than the new polymer (**right, in Figure 2**).
- If similar results were true for drug particles it would mean that the new polymer might reduce face mask drug depletion.

Main assessment

- Mean $\pm$ SD (μ g) salbutamol sulphate per actuation retained on each of the face masks is given in the Table.
- Face mask ratio of deposition is 26 : 14 : 1 where 1 is the A2A Spacer new polymer face mask.



VHC + face mask polymer type (n=5)	salbutamol sulphate per actuation µg (mean ± SD)
A. AeroChamber + silicone polymer face mask	5.65 ± 1.48
B. A2A Spacer + silicone polymer face mask	3.09 ± 0.72
C. A2A Spacer + new polymer face mask	0.22 ± 0.14
Ratio (A : B : C)	26 : 14 : 1

- Research has previously focused on the static effect of VHCs. This research indicates that face mask material can have a marked impact on dose depletion when the tidal breathing technique is used.
- The clinical implications of this finding are relevant to VHC users.
- Moisture from a young user's tidal breathing pattern may affect face mask anti-static properties. This requires further investigation.

- We have recently determined that anti-static pre-treatment and bagging of the A2A Spacer contributed to improved drug delivery characteristics of Ventolin pMDI.⁴
- Our work to date suggests that the issue of static generation and dissipation is an important and under-researched aspect of overall VHC development.

1. Amirav I, Newhouse MT. Review of temporal characteristics of face-masks for valved-holding chambers (VHCs). *Pediatric Pulmonology* 2008, 43: 268-274 (doi:10.1002/ppul.20767).
2. Sanders et al. Effect of valved holding chamber (VHC) facemask material on drug delivery. Association of Respiratory Nurse Specialists Conference (The Brave New World of Respiratory Care), Warwick, UK, 2014, 14-15 April.
3. Schultz EA, Le Souëf TJ, Venter A, et al. Aerosol inhalation from spacers and valved holding chambers requires a few tidal breaths for children. *Pediatrics* 2010, 126 (6): e1493-e1498 (doi:10.1542/peds.2010-1377).
4. M. Sanders et al. Emergency room use of valved holding chambers (VHCs) - Can it be improved? European Respiratory Society Annual Congress, Munich, 10 September 2014. EPRS01.

**We gratefully acknowledge the assistance of
David Spencer and Janet Allan
of Clement Clarke International Ltd.**