In Vitro Effect of Different Airflow Rates on the Aerosol Properties of Nebulized Glycopyrrolate in the eFlow® Closed System and Tiotropium Delivered in the Handihaler®

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COPD

4th *leading cause of mortality in the US*[1]

15.7 million
adults diagnosed in US[1]

INTRODUCTION

- Aerosol properties and device characteristics of inhalation therapies play key roles in drug delivery, with particle sizes 1–5 µm aerodynamic diameter in the respirable range.
- The average age of patients with COPD is increasing;[2] comorbidities, exacerbations and low inspiratory flow rates are common among older patients with COPD and may impair drug delivery and treatment efficacy.

OBJECTIVE

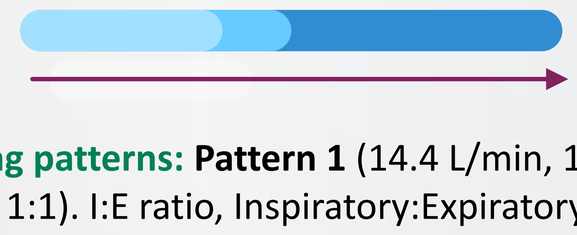
In this *in vitro* study, we compared the aerosol performance and drug-delivery properties of two long-acting muscarinic antagonists – tiotropium (TIO; 18 µg actuation powder) delivered via Handihaler® high resistance dry-powder inhaler (DPI) and glycopyrrolate (GLY; 25 µg solution; 1 mL) delivered via eFlow® closed system (CS) nebulizer.

METHODS

A next-generation cascade impactor (NGI) was used to assess particle size distribution of GLY in the eFlow® CS nebulizer and TIO in Handihaler® devices.

- **eFlow® CS nebulizer**: A breathing simulator was used under three breathing patterns*, corresponding to tidal volumes of **200, 350 or 500** mL.

- **Handihaler®**: A constant flow rate of **20, 30 or 60** L/min was used.



- Aerosol properties were determined using **Copley inhaler testing software**.

*Parameters (PIFR, frequency, I:E ratio) for the three breathing patterns: **Pattern 1** (14.4 L/min, 10 breaths/min, 1:3.6); **Pattern 2** (15.6 L/min, 12 breaths/min, 1:1.4); **Pattern 3** (23.4 L/min, 15 breaths/min, 1:1). I:E ratio, Inspiratory:Expiratory ratio; PIFR, peak inspiratory flow rate.

RESULTS

Aerosol characteristics of GLY via eFlow® CS nebulizer

Greater deposition in the later stages of the NGI

DRUG PARTICLE SIZE (MEAN [RANGE])

Breathing pattern	Particle size (µm)
1	4.1 (3.6–4.6)
2	4.2 (4.0–4.3)
3	3.9 (3.7–4.1)

FINE PARTICLE FRACTION

Between **48–64%**

RESIDUAL DOSE

2.4–4.4%

Aerosol characteristics of TIO via Handihaler®

Greater deposition in the USP throat of the NGI

DRUG PARTICLE SIZE (MEAN [RANGE])

Flow rate (L/min)	Particle size (µm)
20	5.3 (4.9–5.8)
30	4.7 (4.5–5.0)
60	3.9 (3.8–4.0)

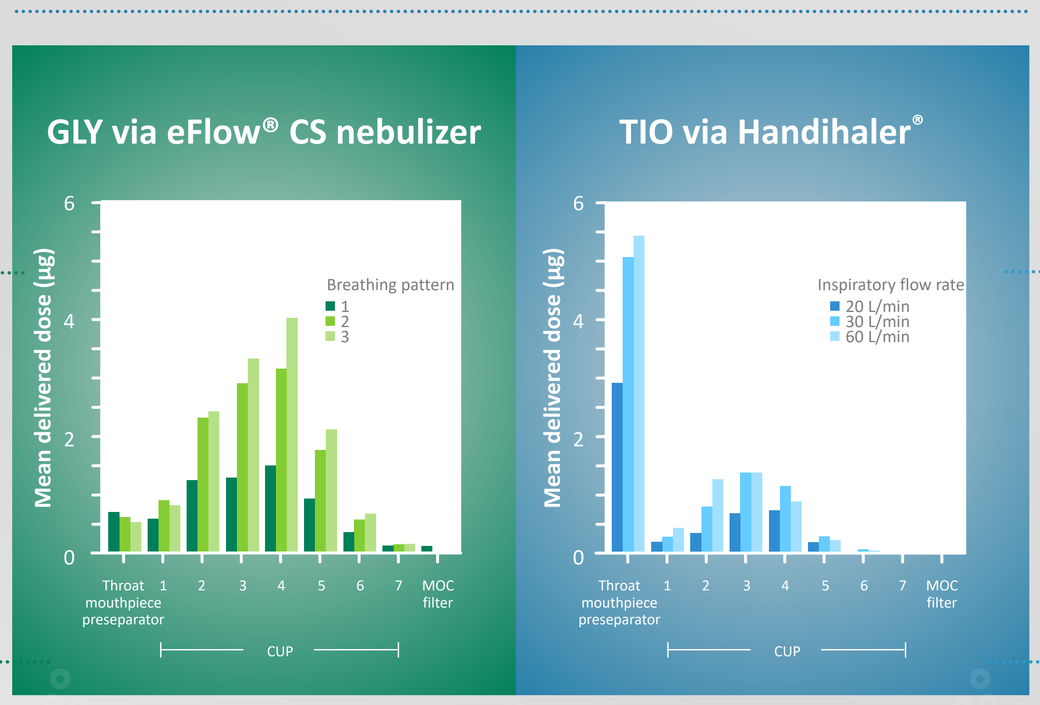
FINE PARTICLE FRACTION

Between **16–32%**

RESIDUAL DOSE

40–67%

NGI STAGE-BY-STAGE DEPOSITION PROFILE



CS, closed system; GLY, glycopyrrolate; MOC, micro-orifice collector; NGI, Next Generation cascade Impactor; TIO, tiotropium

LONHALA® vial | **SPIRIVA® capsule**

KEY TAKEAWAYS

- **Delivery of GLY via eFlow® CS nebulizer resulted in consistent drug particle size within the respirable range, high rate of particle delivery and greater deposition of drug particles within the later stages of the NGI across all breathing patterns evaluated in this study.**
- **At breathing pattern 1 (200 mL tidal volume), the particle size of GLY was more variable and deposition of GLY using the eFlow® CS nebulizer was lower in the later stages of the NGI, compared with the other breathing patterns tested. These differences may be a result of the defining features of this breathing pattern, which are consistent with patients with severe COPD.**
- **This study highlights differences in deposition patterns between an eFlow® CS nebulizer and a Handihaler® and may help inform device selection and treatment decisions in COPD.**

PEER-REVIEWED INFOGRAPHIC

1. US Centers for Disease Control and Prevention (CDC). 2019. (CDC). 2019. https://www.cdc.gov/copd/basics-about.html **2.** Easter M et al. *Int J Mol Sci*. 2020. The infographic represents the opinions of the authors and was funded by Sunovion Pharmaceuticals Inc. For a full list of declarations, including funding and author disclosure statements, please see the full text online: In vitro effect of different airflow rates on the aerosol properties of nebulized glycopyrrolate in the eFlow® closed system and tiotropium delivered in the HandiHaler®, Ohar JA, et al. *Pulm Ther*. 18 August 2020. doi:10.1007/s41030-020-00125-6.

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