Performance of a Contact-Triggered Vibrating Mesh Nebulizer: A Comparison to Traditional Mesh Nebulizer

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Summary

Knowing and understanding the performance of vibrating mesh nebulizers is critical since it is related to the ease of inhalation drug delivery. Cleaning processes to avoid cross-contamination of different drugs and mesh clogging are two disadvantages mostly being recognized among vibrating mesh nebulizers. The present study compared the Mass Median Aerodynamic Diameter (MMAD), Geometric Standard Deviation (GSD), Fine Particle Fraction (FPF) percentage, and vibration modal patterns during nebulization among two types of polymer-based MicroBase Technology (MBTC) Pocket Air® nebulizers, newly launched contact-triggered vibrating mesh nebulizers. These were compared with Aerogen® Solo, PARI VELOX® and PARI eFlow® rapid. The results are as follows:

- Contact-triggered vibrating mesh (CTVM, Microbase Technology Pocket Air®)
- Portable nebulizer (NEB, Microbase Technology Pocket Air®)
- Solo (Aerogen®)
- VELOX® (PARI)
- eFlow® Rapid (PARI)

A similarly of MMAD and GSD results for the above nebulizers were tested (each 3 devices in 1 repeat), and revealed in Figure 3. Furthermore, the FPF of CTVM from is shown for Ipratropium bromide (0.5mg/2 mL) which is approximately 1.2 times greater than that of NEB, Aerogen® Solo, and PARI VELOX® rapid (108.6 kH, 125.9 kHz, 124 kHz and 117.9 kHz, respectively). These results are from the study of Naoyoshi Maehara, Sadayuki Ueha, and E. Mori, Influence of the vibrating system of a multipihole vibrating mesh nebulizer on its performance. Review of Scientific Instruments, 1986. 57(11): p. 2870.

Experimental Materials & Methods

A 248 nm UV range excimer laser source (with output power 300 mJ and firing frequency of 200 Hz), optical path system, and MBTC, Aerogen


Results and Discussion

The Mass Median Aerodynamic Diameter (MMAD) and fine particle fraction percent less than 5 μm (FPF (<5 μm)) result revealed by MBTC, Aerogen® Solo, and PARI eFlow® rapid. Data for MMAD was collected by Nest Generation Impactor (NGI Models 179, Coley Scientific Limited, UK) with HPD filter system (Alliance 2695, Waters, USA) using analysis ranging from 0.5 to 5 μm. The vibration modal pattern and resonance frequencies of each nebulizer during measurement were determined by the laser Doppler Vibrometry (Polytech PSV-500, OFV-500, Polytec GmbH, Waldbronn, Germany).

Aerosolization ability using Ipratropium bromide (0.5mg/2mL) was chosen for performance comparison with CTVM and NEB from MBTC, Aerogen® Solo, PARI VELOX® and PARI eFlow® rapid. The FPF of NEB was 3.5 % FPF from CTVM is shown for Ipratropium bromide (0.5mg/2 mL), which is approximately 1.2 times greater than that of NEB. Copley Scientific Limited, UK) with HPLC system (Alliance 2695, Waters, USA) using analysis ranging from 0.5 to 5 μm. The vibration modal pattern and resonance frequencies of each nebulizer during measurement were determined by the laser Doppler Scanning Vibrometer (Polytech PSV-500, OFV-500, Polytec GmbH, Waldbronn, Germany).

Conclusion

In this study, nebulizer performance comparison was conducted on contact-triggered vibrating mesh (CTVM) and NEB, and with commercialized Aerogen (Aerogen® Solo) and PARI (PARI VELOX® and eFlow® rapid). The MBTC CTVM nebulizer presents comparable performance to commercially available MBTC NEB, Aerogen® Solo, PARI VELOX® and eFlow® rapid. The FPF (<5 μm) of CTVM nebulizer was comparable to that of MBTC NEB. PARI VELOX® and eFlow® rapid, but 20% greater than that of Aerogen® Solo. Furthermore, these nebulizers showed similar vibration modal (concentric circle pattern) during operations. As a result, the CTVM nebulizer exhibited a comparable performance to current traditional vibrating mesh nebulizers. A disposable medicine cup nebulizer was developed and further studies will be conducted to understand how NEB and CTVM will perform with most liquid to suspension drug formulations as well as under different testing conditions.

Introduction

Inhaled medication plays a crucial role in treating patients with pulmonary and some systemic diseases. In order to improve the delivery efficacy, the liquid medication must be transformed into medical aerosol with specific droplet size. Several researches revealed that the droplet size of medical aerosol should be controlled to 1 to 6 μm because the droplets could deposit in the mouth and throat when the size is larger than 6 μm and may be inhaled when the size is smaller than 2 μm[1,2]. However, traditional vibrating mesh nebulizers are mechanically and electrically unsuitable for use in real life. Therefore, these were compared with Aerogen® Solo, PARI VELOX® and PARI eFlow® rapid. The results are as follows:

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Reference