"AEROSOL DRUG DELIVERY VIA MECHANICAL VENTILATION" VCU # 12-027

Applications

- Pharmaceutical aerosol delivery via mechanical ventilation
- Critical care and portable mechanical ventilation
- For use in neonatal patients, infants, and adults

Advantages

- Aerosol sizes of less than 1µm
- Increased deposition to lung periphery
- Reproducible dosing in multiple patients
- Minimal exhalation of droplets
- Easily manufactured

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Market Need

Aerosolized pharmaceuticals delivered to the respiratory tract via mechanical ventilation have been shown to provide significant medical benefits to both infants and adults patients. Pulmonary drug delivery provides several significant challenges, especially with infants and neonates. Current techniques, such as metered dose and mesh nebulizers, result in approximately 10-20% deposition in the lungs and less than 1% delivery in infants, with the majority of aerosol depositing in the tracheobronchial region. The main cause of early deposition is the large size - approximately 2-7 µm of the aerosol droplets. Yet attempts to decrease aerosol size to less than 1 µm have resulted in large exhalation fractions of the drug with no increases in delivery efficiency. Previous attempts to utilize electrospray techniques have been looked at and rejected due to ozone, a lung irritant, production and cost inefficiency. Thus, further research into novel methods for effectively delivering nanometer size aerosolized pharmaceuticals is needed.

Technology Summary

This is a novel design for a wick electrospray device to deliver pharmaceuticals to the respiratory pathway via a mechanical ventilator. Attaching in-line with ventilator tubing, the device has two modes of operation corresponding to two classes of aerosol size: either 100-900 nanometers or less than 100 nanometers. Utilizing these aerosol sizes, preliminary models demonstrate 62.4% delivery efficiency to the lungs in an infant, versus less than 1% utilizing current sized aerosols. Thus, this technology allows for dramatically increased drug delivery to the lungs of mechanically ventilated patients with minimized exhalation of the aerosol droplets.

Table 3. Deposition in the lungs and total lung delivery.

Flow rate (LPM)	d_p (nm)	DE (%) Total	DE (%) TB	DE (%) Alveolar	Total lung delivery (%)[a]
0.6 LPM minute ventilation	50	90.8	35.4	55.3	72.5
	500	92.6	64.6	28.7	71.7
	4900	94.7	94.7	0.0	38.8
	7000	97.5	97.5	0.0	11.7
1 LPM minute ventilation	50	92.8	30.1	62.7	62.4
	500	95.5	60.5	63.5	60.6
	4900	96.1	96.1	1.1	1.1
	7000	98.4	98.1	0.9	0.9

[a] Percent of initial dose depositing in the lungs

Technology Status

Patent pending: U.S. and foreign rights are available.

This technology is available for licensing to industry for further development and commercialization.