

# Albuterol Delivery in an In Vitro Pediatric Ventilator Lung Model: Comparison of Jet, Ultrasonic and Mesh Nebulizers

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## Abstract

**Objective:** To determine the influence of nebulizer types and nebulization modes on bronchodilator delivery in a mechanically ventilated pediatric lung model.

**Design:** In vitro, laboratory study.

**Setting:** Research laboratory of a university hospital.

**Interventions:** Using albuterol as a marker, three nebulizer types (jet nebulizer, ultrasonic nebulizer, and vibrating-mesh nebulizer) were tested in three nebulization modes in a nonhumidified bench model mimicking the ventilatory pattern of a 10-kg infant. The amounts of albuterol deposited on the inspiratory filters (inhaled drug) at the end of the endotracheal tube, on the expiratory filters, and remaining in the nebulizers or in the ventilator circuit were determined. Particle size distribution of the nebulizers was also measured.

**Measurements and Main Results:** The inhaled drug was  $2.8\% \pm 0.5\%$  for the jet nebulizer,  $10.5\% \pm 2.3\%$  for the ultrasonic nebulizer, and  $5.4\% \pm 2.7\%$  for the vibrating-mesh nebulizer in intermittent nebulization during the inspiratory phase ( $p < 0.01$ ). The most efficient nebulizer was the vibrating-mesh nebulizer in continuous nebulization ( $13.3\% \pm 4.6\%$ ,  $p < 0.01$ ). Depending on the nebulizers, a variable but important part of albuterol was observed as remaining in the nebulizers (jet and ultrasonic nebulizers), or being expired or lost in the ventilator circuit (all nebulizers). Only small particles (range 2.39-2.70  $\mu\text{m}$ ) reached the end of the endotracheal tube.

**Conclusions:** Important differences between nebulizer types and nebulization modes were seen for albuterol deposition at the end of the endotracheal tube in an in vitro pediatric ventilator-lung model. New aerosol devices, such as ultrasonic and vibrating-mesh nebulizers, were more efficient than the jet nebulizer.

**Keywords:** Aerosols, Drug delivery, Infant, Mechanical ventilation, Nebulizer, Particle size distribution.