

## Optimal Parameters for Pulmonary Particle Deposition as Function of Age

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### Abstract

Background: As a result of dissimilarity in lung morphometry and physiological conditions, therapeutic aerosol particles deposit differently in humans of various ages and body weights. Recently, clinical findings observed low inter- and intra- patient reliability in dosing, suggesting that a single aerosol device and particle size distribution is ineffective. Methods: This work conducts a formal optimization study to determine the optimal particle size distribution for maximum drug delivery for a 2, 9 and 21 year old individual over a range of breath rates. The work also explores the optimal particle size distribution for the therapeutic aerosol to provide the same dose volume regardless of breath rate. This study utilizes classical, static statistical, probabilistic models in conjunction with lung cast data to calculate deposition and imparts population variation within normal distributions. Results: This study finds that both optimal particle size for maximum volume weighted deposition efficiencies are age/weight dependent as well as breath rate dependent. A monodisperse particle size is obtained even when a polydisperse spray is allowed for optimization when investigating a single condition (i.e., age or flow rate). The optimal particle size increases from 2 to 5  $\mu\text{m}$  for toddler to adults, while the optimal size decreases from 5 to 3  $\mu\text{m}$  for a 21 year old adult with a flow rate increasing from 13 to 60 L/min. Optimizing the particle size distribution for reliable dosing of a 21 year old adult was dependent on the minimum dose volume constraint applied. As the dose volume constraint increased from 0.1% to 5% a single peak at 0.5 micron was replaced by a bimodal distribution and the mean size grew.