Can machine learning predict particle deposition at specific intranasal regions based on computational fluid dynamics inputs/outputs and nasal geometry measurements?

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Along with machine learning modeling, numerical simulations of respiratory airflow and particle transport can be used to improve targeted deposition at the upper respiratory infection site of numerous airborne diseases. Given the need for more patient data from varied demographics, we propose a machine learning-enabled protocol for determining optimal formulation design parameters that may match nasal spray device settings for successful drug delivery. We measured 11 anatomical parameters (including nasopharyngeal volume, nostril heights, and mid-nasal cavity volume) for 10 CT-based nasal geometries representative of the population for this aim. We also ran 160 computational fluid dynamics simulations of drug delivery on the same geometries for various breathing situations, using varied pressure gradients to drive inhaled air transport to evaluate drug deposition at the various upper airway areas for nasal inhalers. Using this test data, we constructed 18 machine-learning models to estimate the targeted deposition at the different regions of the upper airway. This study contributes to developing a customized, efficient intranasal delivery system for prophylactics, treatments, and immunizations; the findings will apply to a broad spectrum of respiratory disorders.