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Cluster-guided imaging-based CFD analysis of airflow and particle deposition in asthmatic human lungs.[1] JIWOONG CHOI, LAWRENCE LEBLANC, University of Iowa, SANGHUN CHOI, Kyungpook National University, BABAK HAGHIGHI, ERIC HOFFMAN, CHING-LONG LIN, University of Iowa
— The goal of this study is to assess inter-subject variability in delivery of orally inhaled drug products to small airways in asthmatic lungs. A recent multiscale imaging-based cluster analysis (MICA) of computed tomography (CT) lung images in an asthmatic cohort identified four clusters with statistically distinct structural and functional phenotypes associating with unique clinical biomarkers. Thus, we aimed to address inter-subject variability via inter-cluster variability. We selected a representative subject from each of the 4 asthma clusters as well as 1 male and 1 female healthy controls, and performed computational fluid and particle simulations on CT-based airway models of these subjects. The results from one severe and one non-severe asthmatic cluster subjects characterized by segmental airway constriction had increased particle deposition efficiency, as compared with the other two cluster subjects (one non-severe and one severe asthmatics) without airway constriction. Constriction-induced jets impinging on distal bifurcations led to excessive particle deposition. The results emphasize the impact of airway constriction on regional particle deposition rather than disease severity, demonstrating the potential of using cluster membership to tailor drug delivery.

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