Transport and Deposition in the Terminal Bronchioles of Large Scale 17-Generation Model

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Abstract

The understanding of the complex inhalation and transport procedure of the toxic pollutant particles through the human respiratory system is important for dosimetry and respiratory health effects analysis. The studies over the last few decades for nanoparticle transport and deposition improves the understanding of the drug-aerosol impacts in the mouth-throat and the upper airways. The comprehensive nanoparticle transport and deposition analysis data in the terminal bronchioles of the lung airways is still not available. The present study is the first ever approach to simulate the ultrafine particle transport and deposition in the terminal bronchioles of the 17-generation whole lung model by considering possible entire branching pattern. The anatomically explicit digital 17-generation conduit model is generated from the high-resolution CT data. Unstructured tetrahedral mesh throughout the geometry and fine inflation layer mesh near the wall are generated. Euler-Lagrange (E-L) approach and ANSYS (17.1) Fluent solver are used to investigate the ultrafine particle transport and deposition. The nanoparticle transport and deposition are investigated for a wide range of diameter ($1 \leqslant nm \leqslant 1000$) and different flow rates. A comprehensive pressure drop is calculated throughout the 17-generation model for various lobes, which might be helpful for the therapeutic purpose of the asthma patient. The numerical study performed comprehensive lobar deposition and showed different deposition hot spot at various lobes of the human lung. The deposition efficiency in different lobes is different for different flow rates, which could help the health risk assessment of the respiratory diseases and eventually could help the targeted drug delivery system. The findings of the present study will improve the understanding of the nanoparticle transport and deposition in the terminal bronchioles of a whole lung model.