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Novel computational models of human lung show personalized medicine potential

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The models have been developed and presented by Computational Fluid Dynamics Research Corporation (CFDRC) in collaboration with Philip Morris International (PMI).



Singapore – Details of novel computational models of the human lung have been presented at the 10th International Aerosol Conference (IAC). The personalized models, based on advanced mathematical modeling of the human body and lung geometry, can be used to predict how aerosols will be inhaled, deposited on airway walls, and absorbed and cleared by lung physiology. Combining high-performance computing, high-fidelity modeling, and high-resolution medical imaging, the simulations have significant potential to contribute to new diagnostic tools and treatment options for respiratory disease. The models have been developed and presented by Computational Fluid Dynamics Research Corporation (CFDRC) in collaboration with Philip Morris International (PMI).

“Environmental exposures, tobacco smoke, and air pollution are common risk factors for acute and chronic respiratory diseases,” said Dr Andrzej Przekwas, Chief Technology Officer, CFDRC. “However, each human is unique and responds differently to exposure to these compounds. Respiratory health depends on the properties of the inhaled aerosol, the evolution of compounds in the airways, and their deposition, transport, absorption, and elimination based on the specific physiology of the individual. We are now able to accurately model these complex paradigms of exposure at the level of both the individual and, by extension, the population.”

In the models presented at IAC, PMI’s algorithms work alongside CFDRC software to predict and quantify the behavior and effects of aerosols on the human body. The software combines analyses of pharmacokinetics, assessing how aerosols move through the airways during distribution, absorption, metabolism, and excretion, with a system biology pharmacodynamics tool to determine how the aerosols interact with cells and metabolic pathways. Models are based on lung and body measurements taken from human respiratory system imaging datasets (computerized tomography (CT) scans), with templates modified based on individual-specific factors (e.g. height). They have been validated against previously published models and experimental data.

CFDRC specializes in developing innovative simulations for industries including biotechnology, energy, materials, and aerospace. They have pioneered multi-scale, multi-physics simulations of fluid, thermal, chemical, biological, electrical, and mechanical phenomena for real-world applications. PMI is developing a portfolio of Reduced-Risk Products (RRPs), products with the potential to reduce individual risk and population harm in comparison to cigarettes. Through technological innovation and rigorous scientific assessment, they are leading a full-scale effort to ensure RRPs ultimately replace cigarettes.