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COMPUTATIONAL MODELING OF THE RESPIRATORY SYSTEM

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ABSTRACT

We show recent advances in developing a comprehensive computational model of the respiratory system based on different novel multi-field and multi-scale approaches.

The human lung is still only a very poorly understood system. For many reasons however it would be very beneficial to get deeper insights in various phenomena as e.g. dispersive aerosol transport or ventilator-induced lung injury (VILI). Our efforts that are described in this talk are heading towards a better understanding of ventilator-induced lung injury and the development of new protective ventilation strategies that are able to decrease the high mortality in this area. To reach this goal a detailed understanding of fluid and solid mechanical processes at different levels – from the trachea down to the alveolar and even cellular level – is necessary.

On the largest scale the model incorporates fluid-structure interaction effects in the first generations of the bronchial tree. Patient-specific geometries obtained from CT scans are enhanced via special boundary conditions and artificial extensions allowing information transfer to non-resolved areas and finally to the alveolar area where VILI occurs. In the respiratory zone a dynamic nested multi-scale approach was established. This is based on a detailed micromechanical model including complex constitutive models of alveolar tissue – obtained from experiments on living lung slices – and surfactant effects. At the lowest scale also force transmission in cells is tackled.

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