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Airway flow modelling using Nek5000: Insights for gas transport during high-frequency ventilation

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High-frequency ventilation (HFV) is a medical ventilation technique that uses fast yet shallow inflations, resulting in small peak pressures, thereby protecting lungs from over-distension. While several mechanisms have been proposed for gas transport during HFV, this process is still not well understood, and it is likely the treatment as it stands is sub-optimal. Nonlinear mean streaming and turbulent diffusion are two mechanisms with the potential to be further exploited for gas transport. The work presented here aims to characterize and quantify these mechanisms in geometries, and at parameters, which are relevant to the application of HFV. These mechanisms have been investigated systematically in models with varying complexity –in a single generation and multi-generation bifurcating tubes. The geometries of the models are constructed to model a portion of the approximately self-similar human airway so that the flow in different portions can be modeled by simply changing model parameters. These findings are then extrapolated to quantify the role of these gas transport mechanisms in the entire airway.

Finally, the overview of a flow-splitting algorithm is presented to highlight its use in combining numerical simulations with clinical measurements.

Relevance for Nek [100 words max]

This is an example of the use of Nek5000 in the modelling of airway flow in both idealized and realistic (patient-specific) airway geometries.

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