Multi-scale models of cerebral blood flow and metabolism

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Abstract

The human brain relies on a continuous sufficient supply of blood to maintain the body's multiple functions through the delivery of oxygen to brain tissue. Even short interruptions can lead to a rapid lack of oxygen and cell death with severe consequences to brain function. Such interruptions are implicated in a range of diseases, most obviously stroke but also neurodegenerative diseases such as dementia. However, our knowledge of the cerebral vasculature remains surprisingly incomplete, and the very large number of blood vessels involved also makes understanding the brain's response to physiological challenges very difficult. Computational models of cerebral blood flow have a long history of attempting to understand the brain's behaviour in both healthy and diseased conditions, although only recently has it been possible to model the whole brain in a fully 3D manner. In this talk, I will present the work that has been done to construct these whole-brain simulations, in particular the use of multi-scale methods to bridge the different length scales and their application in stroke. I will discuss how these models can now be used to consider multiple time scales, which will be needed to consider longer-term clinical diseases such as dementia. Finally, I will focus on how these models can be applied in the next few years directly in clinical scenarios to assist clinicians in diagnosis, prognosis, and treatment of multiple brain diseases.