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Computational fluid dynamics (CFD) in congenital heart disease and thrombosis: The role of high performance computing (HPC)

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Computational fluid dynamics (CFD) has proven to be a powerful tool for elucidating flow features in a range of disease cases. The technique can be used in combination with other approaches to capture key features of a specific disease. In this talk, we consider two disease cases that have benefitted from high performance computing (HPC). The first case, Coarctation of the Aorta (CoA), is a congenital heart defect which is present at birth and alters the distribution of blood in the body. The effects of the disease tend to be present in childhood and beyond, and medical intervention aims to manage the condition throughout the lifetime of the patient. Haemodynamic simulations, based on CFD, can give insight into how different treatment interventions are likely to impact local fluid dynamics. In order to compute these flow solutions, patient specific boundary conditions can be obtained using echocardiography and where datasets are incomplete, augmented with machine learning approaches. The outputs from the CFD model can be used as inputs for an agent-based model (ABM), which shows great potential for capturing growth. The second case, thrombosis, or blood clotting is a condition which is present in a number of diseases. CFD is coupled to biochemistry to capture local haemodynamics and chemical reactions. The growing clot is captured as a porous medium which affects blood flow and the transport of chemical species. In some instances, devices used for treatment can also be modelled in the flow domain. For both disease cases, the modelling processes described take place over different timescales and require careful consideration of computing resources.

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No. Not a student nor Postdoc.

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