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Simulation-based planning of surgical interventions in pediatric cardiology

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Hemodynamics plays an essential role in the progression and treatment of cardiovascular disease. This is particularly true in pediatric cardiology, due to the wide variation in anatomy observed in congenital heart disease patients. While medical imaging provides increasingly detailed anatomical information, clinicians currently have limited knowledge of important fluid mechanical parameters. Treatment decisions are therefore often made using anatomical information alone, despite the known links between fluid mechanics and disease progression. Patient-specific simulations now offer the means to provide this missing information, and, more importantly, to perform in-silico testing of new surgical designs at no risk to the patient. In this talk, we will outline the current state of the art in methods for cardiovascular blood flow simulation and virtual surgery. We will then present new methodology for coupling optimization with simulation and uncertainty quantification to customize treatments for individual patients. Finally, we will present examples in pediatric cardiology that illustrate the potential impact of these tools in the clinical setting.