TO ASSESS THE RISK FOR A SURGICAL INTERVENTION: THROUGH FLOW BIOPHYSICAL MODELING OR MACHINE LEARNING?

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Background

Computational modelling based on physical equations of blood or air flow has significantly advanced over the past 20 years. After methods development to make simulations 1) patient-specific by building the geometry and boundary conditions based on patient-data [1], and 2) predictive by changing components of the model (geometry or parameter) while making the hypothesis the other ones are not changing [2].

Recent Advances

Typically however, patient-data are insufficient to estimate all the parameters of the model, i.e. to have a well-posed inverse problem. Different strategies can be adopted to tackle this issue [3]. In particular, machine-learning can offer prior information [4]. Reduced models offer cheaper to run simulations to predict or design the artificial device for an intervention, validated by 3D models and partial clinical data, for example in the context of pulmonary hypertension treated with a Potts' shunt [5]. They allow patient-specific prediction of a surgical risk, such as the risk of portal hypertension in liver partial resection [6], although it requires a careful sensitivity analysis to understand how patient-data and model parameters are related [7].

Future directions

As machine-learning and deep-learning are making so much progress to predict for example the complexity of a surgery [8], what type of models will be more effective to assess surgical risks related to flow changes? Part of the answer is complementarity [9], especially when mechanobiological processes are not fully elucidated and thus not yet put in equations. In any case, a tight collaboration between scientists and clinicians is necessary to bring biophysical fluid models to the clinics, and to design model and data acquisition that are coherent with the surgery of interest.

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