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PERSONALIZED SIMULATION OF CARDIAC FUNCTION AND CORONARY FLOW

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MINI-SYMPOSIUM PROPOSAL

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Cardiovascular diseases remain the leading cause of disability and mortality all over the world. Stable heart function is vitally important for the organism. Various cardiac pathologies are frequently caused by abnormalities of the heart rhythm due to the failure of the conducting system, atherosclerosis of coronary arteries reducing perfusion of the myocardium, heart valve diseases, dilation of the left ventricle, etc. Medical treatment of cardiac pathologies is often associated with high risk invasive interventions such as vascular surgery, pacing, and ventricular assist device installation. Personalized simulations may substantially increase the efficiency of such procedures and decrease side effects.

Numerical simulation of cardiac function and coronary blood flow requires development of multi-scale and/or multi-physics models for flows of complex fluids, fluid-structure interaction, transport processes and metabolism, biochemical reactions in liquid and solid phases, and dynamics of cell and pathogen populations. These and other processes determine normal and pathological functioning of the organism as well as its physiological response to medical treatment. Personalized simulations provide tools for the development of optimized individual strategies for medical treatment.

Real-time patient-specific simulations are highly demanded in clinical practice. Such simulations are often based on models of reduced complexity derived by spatial reduction or machine learning techniques.

This minisymposium will be devoted to personalized mathematical models of the cardiac function, blood flow in the heart chambers and adjoint vessels, coronary circulation, mechanical and biochemical interactions with the surrounding tissues. The minisymposium includes but is not limited to the following topics:

- Methods of blood flow modelling (3D flows in complex domains, fluid-structure interaction, cell-based models, 1D and 0D reduced-order models);
- Drug transport and metabolism modelling;
- Methods of patient-specific modelling;
- Biochemical reactions in plasma, coagulation cascade, the influence of blood flow on clot growth, thrombosis and other disorders related to blood coagulation;
- Atherosclerosis, biochemical reactions in vessel walls, development of chronic inflammation, plaque formation, fluid-plaque interaction, plaque rupture, the influence of blood flow on atherosclerosis development;

- Modelling cardiovascular and coronary network diseases;
- Analysis of ventricular assist device functioning;
- Process coupling across multiple scales, methodology of hybrid modelling.

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