Doctoral School of Information and Biomedical Technologies Polish Academy of Sciences

Subject
The role of interstitium and its properties in the tissue transport processes: modeling, prediction and optimization of selected therapies

Supervisors, contact, place of research
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Discipline of science
biomedical engineering

Project Description
Transport of water and solute diluted in the fluid is crucial for the proper functioning of living organisms. Tissue transport plays a special role, as it enables the supply of components necessary for the functioning of cells, indirectly performs regulatory functions in the processes of local immune response to infections, in inflammatory processes, wound healing, etc., and finally, or perhaps above all, helps to maintain the local homeostasis (balance) within the body. As a result of local forces, difference of pressures (hydrostatic, osmotic, oncotic) and concentrations, transport of water and solutes (by diffusion and convection) through the tissue occurs.

Interstitium - a type of connective tissue that surrounds small blood and lymph capillaries and cells, constitute the medium in which, the mentioned transport processes occur. Transport parameters as well as local forces that induce tissue transport are not constant, but change dynamically as a result of local physiological processes (occurring within the tissue and/or blood circulation) and/or due to external stimuli – such as inflammation, burns, or caused by local therapy. Changes of the interstitial properties, its elasticity or hydration, affect local transport properties of the tissue, and in consequence have impact on the effectiveness of the treatment and the body balance. Recent researches significantly increased our knowledge on the local tissue physiology and processes occurring within healthy and pathological tissue. The modeling of the changes that occurs in the properties of the interstitium and their impact on the drug delivery (as in case of chemotherapy), or solute removal (e.g. during dialysis) allows for more accurate predictions of therapy effectiveness and its further optimization.

Modeling of water and solutes (of different molecular weight and charge) transport at the tissue level will be formulated based on the so-called distributed approach (that takes into account local tissue physiology, its variability, including changes of tissue hydration and transport parameters) taking into account the role of the blood and lymph circulatory systems. Due to the complexity of the relationship between structure and function leading to the highly nonlinear transport phenomena, the proposed model will be solved numerically for the selected therapies. It can be applied to the analysis of various aspects of peritoneal transport and estimation of local transport parameters (based on clinical and experimental data) in healthy and pathological tissues – occurring during peritoneal dialysis (removing substances from the patient's body) and in cancerous tissues (the process of penetration of drugs administered during intraperitoneal chemotherapy).

An example of the use of peritoneal tissue transport modeling can be found in [1,2,3].

Bibliography

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3. M.F. Flessner: The transport barrier in intraperitoneal therapy, Am J Physiol 288, F433- F442 (2005).