TITLE: Optimisation of intraperitoneal chemotherapy by modelling of water and solute transport

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SCIENTIFIC DISCIPLINE: biomedical engineering

PROJECT DESCRIPTION (max. 2500 characters; *containing general information on the scientific purpose of the project and research hypotheses, the current state of art, a short research plan and research methodology*)

Surgical treatment combined with a systemic therapy, such as intravenous chemotherapy, is commonly used treatment method in the course of advanced stage of cancer. A novelty in this field, which can be applied in patients with metastatic cancer placed within short distance from the peritoneal cavity, is the HIPEC - a treatment procedure consisting of a cytoreductive surgery (reducing the tumor mass) combined with so-called intraperitoneal chemotherapy under conditions of hyperthermia. In this therapy, cytostatic drugs are delivered locally bypassing the barrier of the blood capillary wall. Dissolved cytostatics are administered directly into the peritoneal cavity from where, through the tissue layers surrounding peritoneal cavity, are transported with water bulk flow directly to the tumor tissue. The intraperitoneal administration of drugs, that is present in HIPEC, reduces the number of transport barriers as well as the side effects resulting from the high concentration of drug in the blood circulation. This allows for the usage of 20- or even 100-fold higher concentrations of chemotherapeutic agents in the peritoneal cavity than in case of intravenous therapy. Proper selection of treatment parameters leading to the desired depth of tissue penetration by the drug is crucial for the successful therapy.

The aim of the study is to optimize HIPEC therapy by modelling transport processes, which take place during intraperitoneal chemotherapy, based on the local tissue physiology and processes occurring in healthy and neoplastic tissue. A model based on partial differential equations describing the dynamics of water and cytostatic drug transport across the tissue will be implemented and solved numerically, taking into account conditions during HIPEC. Modelling of therapy and processes taking place during the course of HIPEC will be used to optimize treatment dose, predict depth of tissue penetration by drug and to monitor local impact of therapy.

An example of the application of intraperitoneal chemotherapy modelling can be found in [1,2].

BIBLIOGRAPHY

3. Stachowska-Pietka J, Waniewski J. Mathematical Models of Intraperitoneal Drug Delivery. In Intraperitoneal Cancer Therapy. Ceelen W., Levine E. (eds). CRC Press, p. 153-169, 2015 (ISBN 9781482261189)
4. Steuperaert, M. *et al.* Mathematical modeling of intraperitoneal drug delivery: simulation of drug distribution in a single tumor nodule. *Drug Deliv* **24**, 491-501, doi:10.1080/10717544.2016.1269848 (2017)

REQUIREMENTS FOR CANDIDATES

Basic knowledge on the mathematical modeling and programming skills in Matlab.