Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

A multiphysics computational model for design and optimization of drug transport in an endovascular Chemofilter device[1] NAZANIN MAANI[2], TYLER C. DIORIO, Biomedical Engineering, Purdue University, West Lafayette, IN, STEPHEN W. HETTS, Radiology and Biomedical Imaging, University of California, San Francisco, CA, VITALIY L. RAYZ, Biomedical Engineering, Purdue University, West Lafayette, IN — The effectiveness of Intra-arterial chemotherapy (IAC) is limited by the majority of drugs, e.g. Doxorubicin (Dox), that pass into systemic circulation and cause cardiac toxicity. These excessive drugs can be captured by the Chemofilter (CF) – a 3D-printable, catheter based device deployed in a vein downstream of the liver during IAC. The CF chemically adsorbs Dox via ion-exchange with a surface-coated resin. In this study, the CF hemodynamic performance and drug transport were evaluated with multiphysics computational modeling. Device design was optimized using a sensitivity analysis of flow and geometry parameters. The electrochemical binding was modeled based on concentrated solution theory, where diffusion and ion migration were incorporated into an effective diffusivity term. The Navier-Stokes and Advection-Diffusion-Reaction equations were coupled in ANSYS Fluent. The optimized CF consists of an array of hexagonal channels that are twisted, perforated, and aligned with the flow direction to enhance mixing and drug binding. The optimized CF results in a 66.8% drug reduction and pressure drop of 3mm Hg, with model validation by in-vivo porcine studies. These results demonstrate the utility of the CF in improving IAC performance while preventing flow stagnation regions.

[1]NIH NCI R01CA194533 award
[2]Presenting Author

Tyler Diorio
Purdue University, Weldon School of Biomedical Engineering

Date submitted: 01 Aug 2019 Electronic form version 1.4