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3D COMPUTATIONAL MODEL OF THE DRUG PARTICLE TRANSPORT DURING TARGETED DRUG DELIVERY FOR LIVER CANCER

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Unresectable hepatocellular carcinomas (HCC) are currently treated with local injections of chemotherapeutics or radioactive particles during transarterial liver catheterization, aimed at increasing tumor drug concentrations, while limiting systemic toxicity. As optimal treatment conditions are still unknown, we explored the added value of computational models to optimize targeted drug delivery.

A patient-specific 3D hepatic arterial geometry was obtained from micro-CT data and meshed using 8.9 million volume elements. Computational fluid dynamics calculations simulated both the blood flow (continuous shear-thinning fluid phase) and drug transport (discrete phase) in the liver. Boundary conditions included a velocity inlet of 0.155 m/s at the hepatic artery, an outlet flow distribution (Murray's law) and a uniform surface injection of 10^4 particles. The impact of relevant parameters on the particle distribution was analyzed using a sensitivity study.

Results showed that the cross-sectional injection location has a large impact on the particle distribution. A good choice of this parameter may allow targeting specific outlets or tumors. Other parameters having a significant impact on the particle distribution, are the injection plane (proximal/distal catheter position), the particle density (1600-3600 kg/m^3), and the particle diameter (40-100 µm), leading to changes in the outlet-specific number of exiting particles up to ± 64%, 61%, and 79%, respectively.

These preliminary results indicate the potential of patient-specific computational models to optimize targeted drug delivery for liver cancer [1]. Future work will focus on validating and testing the model in a cohort of patients that received transarterial therapy.

References:
[1] Koudehi, G.A., 2016. Masterthesis, Ghent University.