HEMODYNAMIC CAE DESIGN OF BLOOD-WETTED MEDICAL DEVICES USED IN TREATMENT OF CARDIOVASCULAR DISEASE

L.R.Rojas-Solórzano*[1], T.Saliev[2], D.Adair[1], E.Finol[3]

[1]School of Engineering and [2]Center for Life Sciences, Nazarbayev University, Astana, Kazakhstan; *luis.rojas@nu.edu.kz;
[3]Department of Biomedical Engineering, University of Texas at San Antonio, USA

INTRODUCTION.

Cardiovascular Disease (CVD) leads to the major number of deaths in the USA and Europe (European Heart Network, 2008; US National Center for Health Statistics, 2012). In Kazakhstan, CVD represents also the first cause of fatalities (WHO, 2011) with 346.6 per 100.000 of population by 2011, ranking Kazakhstan in 5th place in the world. Despite the best action to reduce CVD being a lifestyle change, medicine and surgical/non-surgical treatment is also needed for severe cases. This project is partnered with the Center of Life Sciences (CLS), a center of excellence at Nazarbayev University created to ¨transform medicine and healthcare in Kazakhstan through innovative scientific research and rapid translation of breakthrough discoveries.

METHODOLOGY.

Design of blood-wetted medical devices using numerical techniques instead of expensive and controversial *ex vivo* and *in vivo* experiments looks as a feasible tool given today´s current computational hardware, software and efficient algorithms. However, the lack of accurate results in the last decade is pushing scientists towards a very expensive and not yet user-friendly use of supercomputers or high-speed mega-clusters as the means to perform Direct Numerical Simulations (DNS) of complex flows with millions of cells travelling in the blood stream. Furthermore, the ultimate design of engineering devices in general is a task that requires an optimization procedure, which entails a careful screening of 10´s or 100´s possible design candidates before determining the appropriate design. Therefore, computationally intensive DNS is still at present not a practical solution to today´s engineering demands, whilst special effort must be placed on improving light, but yet robust 3D numerical models to guarantee appropriate and reliable design tools.

RESULTS AND DISCUSSION.

This work assesses the feasibility of using 3D Eulerian-Eulerian multiphase numerical models to accurately predict blood trauma within biomedical blood-wetted devices. This represents a new stage of an ongoing research undertaken during the last 8 years from which a 3D Eulerian-Eulerian state-of-the-art blood trauma model has already been developed to predict blood cell segregation within stenotic and channel passages, in excellent agreement with experiments.

CONCLUSIONS.

The model presented here has been able also to predict blood cell trauma within an order of magnitude of observations, but it is believed to be an excellent baseline to continue building an improved model based on more realistic approximations of the cell-to-cell and cell-to-wall interactions, recognized as the major distorting element in the model. The improved model will be validated and compared to similar experiments used for the baseline and a case study based on the optimization of a blood-wetted medical device in development by CLS will be executed.