

## In-silico enhanced animal experiments for evaluation of cardiovascular implantable devices

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In-silico modelling of performance of high-risk medical devices holds the promise to reduce or even replace in-vitro and in-vivo methods, such as animal experiments. Nonetheless, animal experiments are still relevant and often even mandatory for medical device evaluation. This study presents an approach on how to use those two methodologies to simultaneously refine the animal experiment and validate the in-silico assessment of medical devices.

This study leveraged data obtained from a chronic animal experiment investigating a pulmonary artery pressure sensor (PAPS) in 10 pigs over a duration of approx. 3 months. The animal experiment focused on assessing the risk of different adverse events, such as device thrombosis and resulting lung embolism. Two sensors have been implanted into each animal in favorable as well as non-favorable positions, aiming to increase the risk of occurrence of these adverse events. CT scans have been performed before and after the device implantation.

An in-silico representation of the animal experiment was conducted. Here, the pulmonary artery was reconstructed from the pre-interventional CT. Virtual device implantation was performed, ensuring that its position mimics the post-interventional CT data. Transient computational fluid dynamics simulations have been carried out to calculate hemodynamic parameters associated with thrombosis, such as oscillating shear indices (OSI) and wall shear stresses (WSS). Changes in pre-interventional hemodynamics due to the implanted device, as well as hemodynamic differences between optimally and non-optimally implanted devices have been assessed. In addition, results of histopathologic examinations regarding occurrence of thrombosis were mapped against hemodynamic results.

The device caused no changes in OSI or WSS and the average pressure drop across the device was below 1 mmHg. Non-optimally positioned devices did not result in relevant changes and no hemodynamic differences to optimally positioned devices was observed. No lung embolism was observed and only small thrombi in the vicinity of the PAPS were found. Pulmonary arteries in which a thrombus was found featured slightly elevated WSS.