

## **Rapid Iterative Development of Blood Conduits for Artificial Kidney Eliminates Thrombosis**

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### **Background:**

Implanted blood contacting devices, particularly dialyzers, tend to require pharmacologic anticoagulation of the patient to avoid local thrombosis and distant thromboembolism. Macrovascular encapsulation of islet cells utilizing a U-shaped device as a bioartificial pancreas was largely abandoned due to complications such as thrombosis. Improved design and manufacturing of devices might avoid the risks and costs of chronic anticoagulation and allow for the successful development of an artificial organ. Computational modeling and in vitro imaging facilitated rapid iterative development of a low-thrombosis blood conduit.

### **Methods:**

Following 3-90 day sustained preclinical implantation trials of hemofilter cartridges, correlations between low shear rates in silicon and areas of clot nucleation in vivo led to modifications of outflow tract geometry. Computational fluid dynamics simulations of unsteady flow in design variations were followed by flow field imaging in vitro. The design with least recirculation and stasis was machined from medical grade polycarbonate and implanted in a Class A dog for 30 days without warfarin or heparin. Serial Doppler ultrasound examinations verified patency of the blood conduits. At postoperative day 30, the device was harvested and examined for thrombosis.

### **Results:**

Optimized designs had increased curvature radius and decreased taper in the outflow tract. The animal suffered no complications of surgery. No hemolysis or distal embolization was noted. The optically transparent cartridge had no visible thrombosis.

### **Conclusions:**

Meticulous attention to the flow fields in a blood contacting device, such as a bioartificial kidney, can reduce thrombosis and eliminate the need for systemic anticoagulation.