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Development of an Implantable Pulsatile Pediatric Ventricular Assist Device

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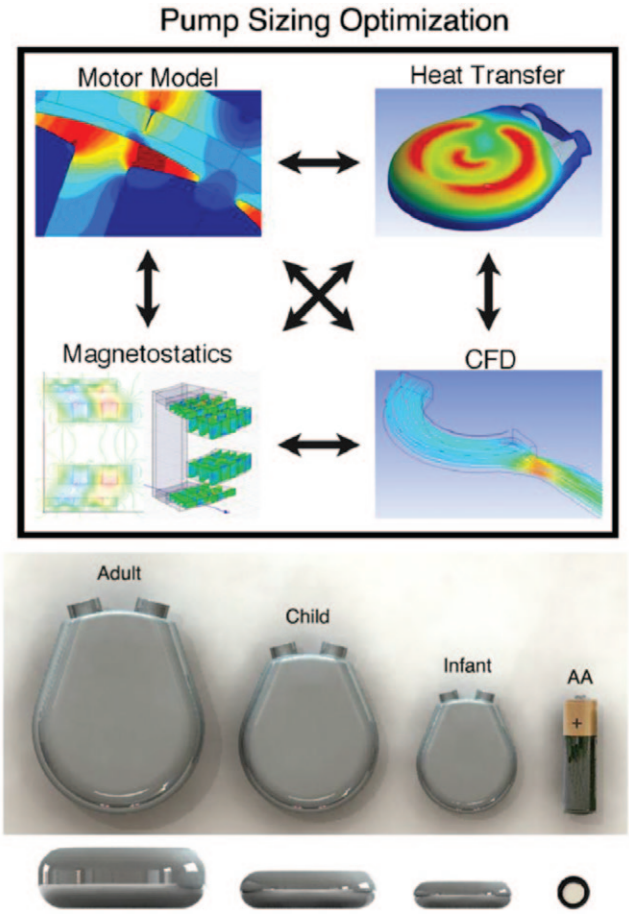
Study: The TORVAD™ is an implantable ventricular assist device able to deliver low-shear, synchronized, pulsatile flow. The key advantages of the TORVAD™ platform include the ability to synchronize with the heart while exposing the blood to minimal shear, as evidenced by low hemolysis and preservation of high molecular weight von Willebrand Factor in a mock loop. Development of the TORVAD™ has previously focused on an adult sized device, and the design principles are now being applied to the development of a child sized version.
Methods: Previously established design tools for the adult TORVAD™ are employed to scale the pump for implantation in children with a body surface area between 0.6 to 1.5 m^2. These design tools include a computational model of the cardiovascular system to predict patient hemodynamics and determine pumping requirements, finite element heat transfer models to minimize heat generation at tissue interfaces, electromagnetic motor design software to maximize motor efficiency, three-dimensional computation fluid dynamics (CFD) to minimize shear and design for thorough washout within the blood pathways of the pump, and finite element magnetostatic simulations to optimize piston/motor magnetic coupling.
Results: Computational cardiovascular system model results predict that a 12 to 15 mL stroke volume pump is capable of fully supporting a pediatric patient by synchronizing with the cardiac cycle and preserving native aortic valve flow. The established computational design tools have been employed to modify and miniaturize the adult TORVAD™ for pediatric support. Use of CFD analysis demonstrates that the device achieves high washout and low shear.



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Venoarterial ECMO Use as a Bridge to Recovery in Beta Blocker Overdose

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Study: 16 year old female who presented after ingestion of an entire 30 day supply of her grandmother's metoprolol and amitriptyline.
Methods: She developed altered mental status and was transported to a local emergency department. She was bradycardic 30-40s, hypotensive 50/20s. Initial resuscitation included 5 Liters of crystalloids, norepinephrine and dopamine infusion. Our transport team arrived, intubated the patient, and started an epinephrine infusion. Upon arrival in our pediatric intensive care unit, her pupils were 7-8s and sluggish, persistent bradycardia 30-40s and hypotensive as before, pulses were weak, a vasopressin infusion was initiated, started on calcium, glucagon, and bicarb infusions. Atropine was ineffective. Her initial complete blood count and electrolytes were normal, creatinine was noted to be increased to 2.7 mg / dL, Tylenol, aspirin and alcohol levels were undetectable. Transaminases were normal. Initial arterial blood gas pH 7.18 / PaCO2 of 35 / PaO2 of 129 / bicarb 13, base deficit 15, lactate of 5 mmol / L. Continuous veno-venous hemofiltration was initiated. As she was refractory to current beta blockade overdose treatment and was persistently bradycardic / hypotensive on 4 different hemodynamic support medications (epinephrine, norepinephrine, dopamine, and vasopressin), she was placed on VA ECMO via a femoral approach. A reperfusion cannula was utilized. She suffered no major complications of her ECMO run. Decannulation successfully occurred after 3 days of ECMO stabilization. Her femoral vessels were subsequently reconstructed.
Results: Her only neurologic impairment was mild memory loss. ECMO support is a viable option for toxic overdose not responding to conventional treatment