Hollow Organ Simulator for in vitro Testing

Chindris, Alexander (School: Episcopal School of Jacksonville)

Hollow organ simulators have been introduced as alternatives to in-vivo testing to study disease mechanisms, therapeutics delivery, and medical devices. To date, these systems don't allow for testing of low-flow, low-pressure systems, such as in the bile duct or venous system. To fit this niche, the engineering goal of this project was to develop a simulator that provides adaptable low-flow and low-pressure environments. The simulator was constructed using low-cost, off-the-shelf components, received simulator pressure and flow rate feedback, and adjusted automatically. It was controlled through an application for mobile devices and allows manual fine control over custom simulator settings. The built prototype consists of a custom assembly of a stepper motor and peristaltic pump head, allowing for adjustable fluid flow rates from 0.0 to 5.0 ml/min, ideal for simulation of bile duct and venous system flow, compression of tubing by a servo motor to allow for adjustable system pressures from 0.0 to 0.20 psi as experienced in the bile duct and venous system. It communicates with mobile devices via Bluetooth to adjust flow and pressure and receives pressure data feedback from the simulator to correct valve settings. Experiments utilizing blood stimulant verified that the constructed simulator achieves target flow and pressures with a controllable pressure curve within the target range and a linear flow rate output of 0.0159 ml/min per step in rpm, allowing fine control over flow rate in the target range. This prototype could become an affordable alternative to traditional in-vivo research models and the more expensive systems currently on the market; further development will verify its utility for medical devices and therapy delivery testing.