High-Flux Hemofiltration System for Rapid Toxin Removal

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Acute poisoning is a clinical problem that affects 2.16 million people each year. Hemofilters, which are designed to remove fluid from the blood during cardiac bypass, can also be used to filter toxins from the bloodstream in certain toxic ingestions. Unfortunately, current hemofilters lack the filtering capacity for many traditionally non-dialyzable toxins, resulting in limited clinical applicability for critical ingestion patients. Commercially available hemofilters lack adequate surface area and are unable to filter blood at high enough rates to remove toxins with a large volume of distribution or high protein binding fraction. Extracorporeal membrane oxygenation (ECMO) is an adjacent technology designed to treat heart and lung failure that circulates blood at high flow rates (4-5 L/min). While ECMO is unable to provide toxin removal, in recent years it has been increasingly used to offer hemodynamic support for critically ill patients suffering from toxic overdose. The goal of this project was to develop an ECMO-compatible hemofiltration system to facilitate rapid and efficient acute toxin removal at high flow rates. By increasing the overall surface area and incorporating the system directly into an ECMO circuit, we sought to overcome traditional challenges with hemofilters to enable rapid filtration of traditionally non-dialyzable toxins. Our team developed a prototype toxin filtration system by creating a parallel “circuit” of eight connected hemofilters. This system can support an input flow rate of 4 L/min, and it was able to remove the non-dialyzable toxin flecainide from saline at an improved and clinically relevant rate. Our final results show a 16-fold increase in the removal rate, with potential for a 21-fold increase, in comparison to traditional hemofiltration. The clinical contribution of this project is a robust, time-saving toxin removal modality for patients who have overdosed on traditionally non-dialyzable drugs.