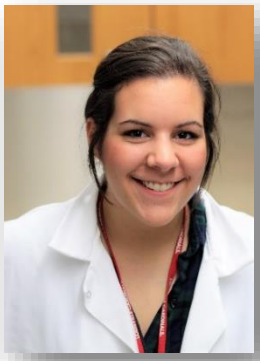
Ultrasound-enhanced Molecular Delivery to Red Blood Cells in a Microfluidic System for Dry Storage

Emily M. Murphy[1], Mariah C. Priddy[1], Brett R. Janis[2], Michael A. Menze[2], Jonathan A. Kopechek[1]
[1]*Department of Bioengineering, University of Louisville, Louisville, KY*
[2]*Department of Biology, University of Louisville, Louisville, KY*

Abstract

Blood transfusions are the most common medical procedures in U.S. hospitals. However, blood has a limited shelf-life of six weeks when refrigerated and storage requirements prevent transfusions in austere environments, including remote medical centers and military operations. To address these challenges our team is pursuing a novel approach to store red blood cells (RBCs) as a dried powder at ambient temperatures, which can be rapidly rehydrated by adding sterile water. In this project we are developing a microfluidic system to enable rapid loading of compounds which protect RBCs during dry storage and rehydration. Our method utilizes ultrasound and microbubbles within the microfluidic device to transiently permeabilize RBC membranes and enable rapid uptake of protective compounds. The objective of this study was to assess the performance of the microfluidic platform on loading compounds into RBCs. PDMS devices with 200-µm channels were fabricated using standard photolithography techniques. Human RBCs were obtained from a commercial vendor. Ultrasound treatment of RBCs in the microfluidic system significantly increased intracellular delivery compared to controls. Optimal parameters for ultrasound pressure, pulse interval, microfluidic flow rate, and microbubble dose were identified in order to increase recovery of viable RBCs after dry storage. Ultimately, this technology could provide a solution to the unmet need for blood storage at ambient temperatures, potentially eliminating the challenges posed by refrigeration or frozen storage of blood while enabling transfusions in austere environments.

Biography of Presenter



Emily is a recent graduate from the Bachelors of Science in Bioengineering program at the University of Louisville. Since fall 2016, she has completed three full-time research co-ops at UofL, with research projects focused on an aptamer-conjugated, cancer-targeting nanoparticle project in addition to developing a new microfluidic method for dry preservation of RBCs at ambient temperatures. She has presented her research at the BMES 2017 Conference, Research!Louisville 2017, Undergraduate Research Symposium 2018 and the Engineering Research Exposition 2018, where she received 2nd place overall. Emily will begin her Masters of Engineering degree in Bioengineering in fall 2018 and plans to attend medical school, with the goal of becoming a pediatrician with a focus in oncology or special needs.