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\$15,000 Lemelson-MIT “Cure it!” Graduate Winner

Enhancing Pain-Free Drug Delivery in Patients via the Gastrointestinal (GI) Tract



The Challenge: Many medicines made from large protein molecules cannot be packaged as a pill because they would be broken down by the enzymes in the digestive system before they are absorbed in the blood. This limits biologics, large drugs made from proteins, to be administered via injections, which are notably painful, invasive, often require a trained professional to administer and offer a risk for unintentional needle injuries. Similarly, those suffering from inflammatory bowel disease (IBD) are limited to invasive and uncomfortable treatment options. IBD, a chronic disease that severely impacts patients' quality of life, requires patients to self-administer enemas and retain the medication overnight. Due to disease symptoms, this timetable hinders the effectiveness of treatments, resulting in poor outcomes.



The Solution: Carl Schoellhammer has developed two separate inventions that both enable systematic localized delivery of biologics across the GI tract. Carl's first invention is the Microneedle Pill (mPill), an ingestible capsule with radially protruding microneedles that allow many drugs to be delivered directly into the dense capillary network of the GI tract, letting patients painlessly self-administer medications. The process of swallowing a “sharp object” is made safe by a pH-responsive coating,

which initially covers the needles, allowing for ingestion. When the mPill reaches the gut, the coating dissolves, revealing the needles, and the peristaltic motion of the gut facilitates the delivery of the drug.

Carl's second invention, the Ultrasound Probe (uProbe), uses ultrasound to physically drive medication into tissue in the GI tract in a safe, painless manner. The low-frequency ultrasound produces acoustic cavitation, where bubbles form in solution and collapse, creating micron-scale jets of fluid that push the drug into the tissue, maximizing mucosal delivery while minimizing retention from hours to just a minute. Carl's team recently reached the finals of the MIT\$100K Competition with the uProbe.

Application and Commercialization: Carl's inventions have the ability to change the current treatment paradigms in gastrointestinal delivery. The mPill and uProbe have the potential to significantly decrease treatment costs (a result of less frequent hospital visits and reduced medication usage), increase patient compliance and enable superior quality of life. Carl's work has recently been published in the *Journal of Pharmaceutical Science*, where it was held in wide acclaim. The most objective piece of evidence surrounding the potential market success is the number of pharmaceutical companies that have expressed interest in the mPill technology. Carl's inventions have the potential to have a positive impact on the safety and comfort of patients, while greatly reducing medical waste and the cost burden of the disease.