



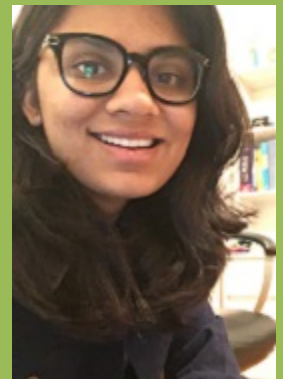
## OUR VISION

The Partnership for Global Health Technologies (PGHT) is a collaboration between the State University of Zanzibar (SUZA), Mnazi Mmoja Hospital, Muhimbili University, and Boston University students. PGHT aims to improve the quality of health care in Zanzibar by applying biomedical engineering principles within a public health context. We use an interdisciplinary approach to address the most pressing issues in healthcare delivery in East Africa.

## STUDENT VOICES

As someone who aspires to become a physician one day, I aimed to find pursuits that allowed me to apply the academics I learned in class to the medical setting, and the Partnership for Global Health Technologies has enabled me to venture that endeavor over the past year and a half. During my time here, I've had the privilege of working with fellow undergrads that inspire me to consistently learn and keep on working despite problems that arise. However, what I'm the most grateful for is that PGHT has provided me, along with my fellow PGHT-mates, the opportunity to collaborate with health care administrators and workers in Tanzania to take a pressing global health issue and innovate a tangible, realistic solution to it- and that is why PGHT will forever be a memorable experience for me and that is what sets PGHT apart from any other pursuit I have been a part of during my undergraduate career. Over the summer, I aim to continue making progress on the electrode design and device-assay integration on the Point-of-Care Liver Function Monitoring device and will be primarily working on the mathematical model of maternal health at hospitals in Zanzibar while in Tanzania.

- MAISHA SAVANI, BIOCHEMISTRY'19



# HUMANITARIAN ENGINEERING COURSE AT AMERICAN UNIVERSITY OF BEIRUT, LEBANON

Over the winter break I traveled with two other PGHT students to Lebanon for a winter term course at the American University of Beirut. The focus of the course was humanitarian engineering in refugee settings. We heard lectures from experts in different fields, including history, public health, architecture, and engineering. The fourth day of the course was a field visit to a Syrian refugee camp. Here, we spoke to refugees about what their main issues were in regards to health, shelter, education, and daily life. As we had discussed in the course the issues of refugees are very complex and are not only technical or health related but have strong political and social links. However, as engineers and health professionals, although we may not be able to change the entire system, we can make a challenge easier.

I learned so much on this trip that I never could have in a classroom. There were many lessons from my two field visits to the camps - some heartbreaking and some uplifting. There was a particularly inspiring moment when a man showed us the drainage system he had built to protect his house from leaking. All of my classmates, myself included, were impressed by his ingenuity.

Getting the opportunity to travel to new places and learn from the experience and being able to work on projects that have a clear impact on society has been one of the most rewarding experiences for me as an undergraduate student. PGHT has enriched my education through projects here in Boston and through experiences abroad in Lebanon and in Zanzibar.

- HELEN LINDSAY, MECHANICAL ENGINEERING'18

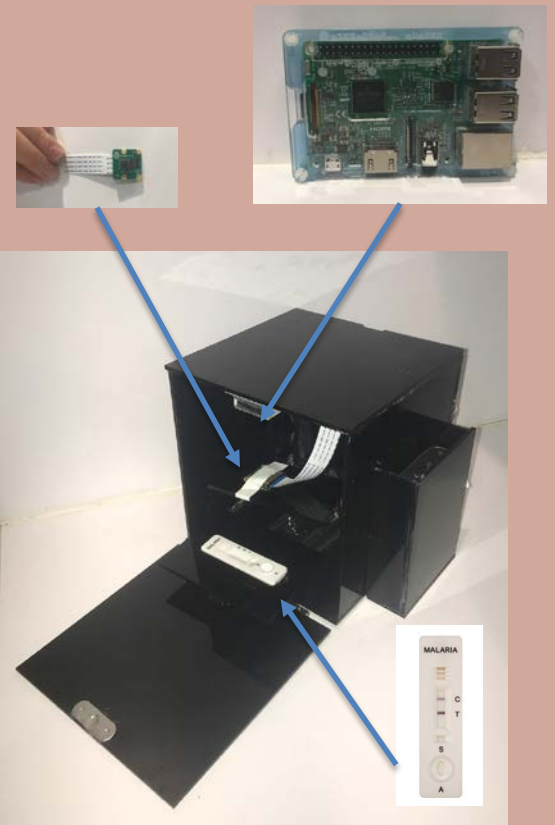




# QUALITY CONTROL OF MALARIA

## RAPID DIAGNOSTIC TEST

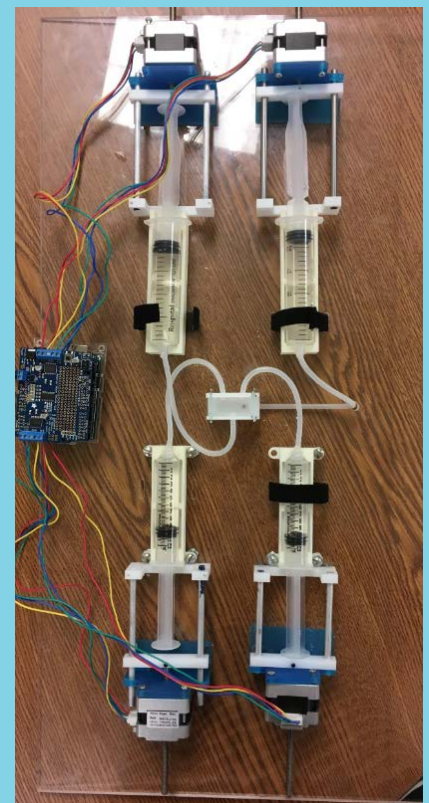
Members of the Quality Control (QC) team have been further developing an imaging device that utilizes an image analysis algorithm to distinguish between true and false mRDT results. Features of the mRDT such as flow front shape, flow rate, and test band intensity are extracted via edge detection and compared to known true and false positive test strips to predict validity. This process will occur in a device that integrates a camera and the algorithm into a closed system, which allows validity to be determined at point of care. Preparations are also underway to stress test mRDTs under varying temperature and humidity to better understand the conditions that may lead to false positives and to test the completed device within the Tanzanian healthcare system this summer.



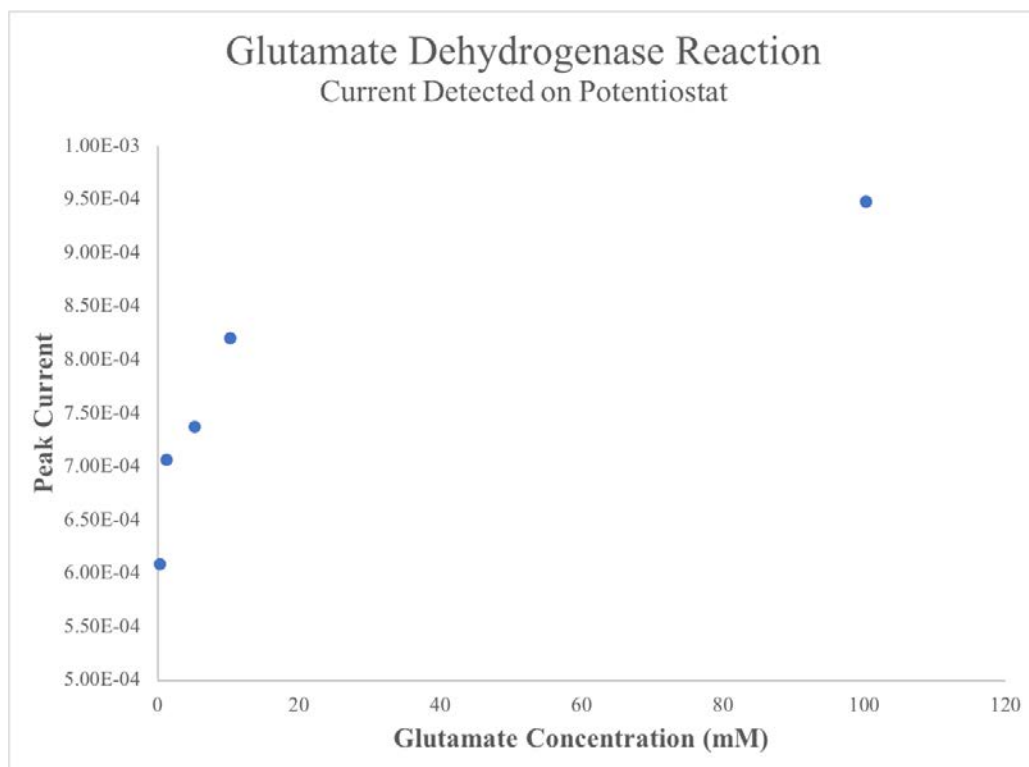
*Prototype of imaging box for data collection, including camera (upper left), Raspberry Pi (upper right) and space for mRDT being imaged (lower right)*

## WATER QUALITY TESTING

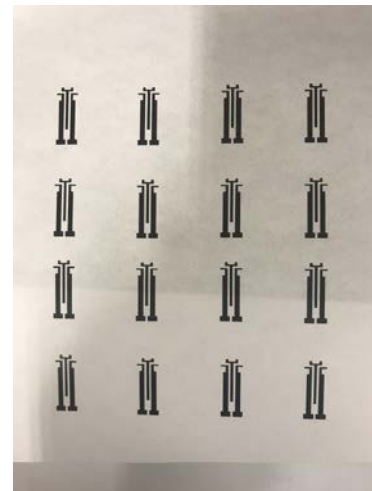
The water quality project has created a device to test for cadmium in water. We are using a cation assay to test for cadmium, which can be used to find out how much cadmium is in a sample by changing the absorption levels at a specific wavelength. We are creating an absorption trend at varying concentrations of cadmium as a way to qualitatively test water with unknown cadmium concentrations. The device will be able to compare absorbance of an unknown sample with this absorption trend to show concentration levels. We are creating a plan for testing in Zanzibar this summer by researching where there are known to be problems in water quality and what areas have not been tested so we can choose locations for testing.



*Prototype of pumping system for heavy metal detection device*



*Assay development for the detection of ALT through a two step chemical reaction*



*Wax printed test strips*



*Glucometer reading wax printed test strip with silver electrode applied*

## POINT-OF-CARE LIVER FUNCTION MONITORING

The team is continuing to focus on fabricating an inexpensive, point of care diagnostic device for the detection of biomarkers AST and ALT, indicators of liver health. During this past semester, we have made progress on the design of the test strip and electrodes. The team has wax printed the test strips onto filter paper, determined the parameters for the electrodes based on the glucometer, and created acrylic stencils for the screen printing of the electrodes using silver conductive ink. Our test strip is able to trigger a response from the store-bought glucometer and we are now working on generating an actual measurement.

Additionally, the team is characterizing and optimizing the electrical current sensed on the potentiostat from the glutamate dehydrogenase (GDH) reaction. We have shown that with increasing amounts of reactant (glutamate), more current is sensed. For our next experiment, we will try sensing current from the GDH-coupled ALT reaction.

# MATHEMATICAL MODELING OF MATERNAL HEALTH AT MNAZI MMOJA HOSPITAL

Looking back at this quarter, the Modeling project has made significant progress. As a team we have completed the first fully functional version of the model and are in the midst of finalizing a manuscript for publishing purposes. This quarter has focused heavily on testing and calibrating the model to get it to simulate the workflows of Mnazi Mmoja Hospital as closely as possible. This has involved running multiple case scenarios and parsing through data to ensure that the model is reflecting the situation on the ground. In order to do this we had to alter how we approached incidence rates and condition distributions. However, after implementing these changes the model closely simulates ward statistics as can be seen by the figure 1 below. With the model functioning to a high degree of accuracy we were able identify what case scenarios we wished to input in to the model in order to generate data that would clearly convey the utility of the model. We decided to focus on the effect of starting stock of essential medicines and number of staff. The motivation for exploring these parameters was due to the frequent occurrences of essential medicines (figure 2) and staff (figure 3) being understocked at Mnazi Mmoja hospital. The model clearly conveys that an increased initial stock of medicine has a positive effect on reducing maternal deaths. Furthermore, it shows how monthly restocking of these medicines can increase the magnitude of this effect. In terms of staffing, the results demonstrated interesting trends showing that an increase doctors from 1 to 2 or 2 to 3 had a significant effect on mortality but this was conditional on the number of nurses. After a certain level, increasing doctors had no effect if there weren't enough nurses.

Overall this quarter has been extremely successful for us as a group. We have a fully functioning model that is outputting encouraging results. We have made progress on preparing a manuscript and generating data that justifies the model well. Looking forward, our plans for the project are to improve the manuscript and send it to journals for publishing. On the model front, we would like to make improvements to the current framework and include aspects like surgery, intensive care units and blood products.

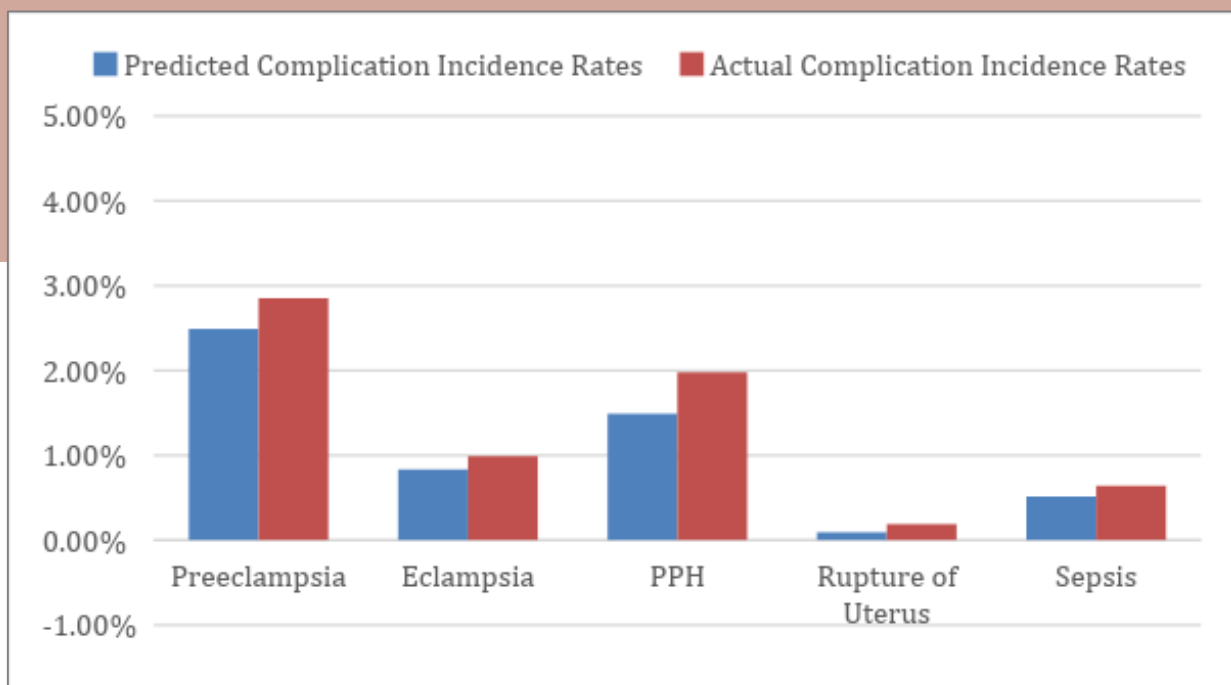


Figure: Model outputted incidence rates vs data collected by a study conducted at the hospital. Morbidity study - Morbidity study: Herklots, Tanneke, et al. "Severe Maternal Morbidity in Zanzibars Referral Hospital: Measuring the Impact of in-Hospital Care." *Plos One*, vol. 12, no. 8, 2017, doi:10.1371/journal.pone.0181470.

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## MESSAGE FROM THE DIRECTOR

Dear Friends of the PGHT Program,

The last quarter saw growth in a new and important dimension. Students from PGHT participated in Humanitarian Engineering Winter School at the American University of Beirut and with that we added a new dimension to our work : engineering in complex humanitarian situations. The winter school was in part designed by PGHT and attracted students and faculty from BU, Johns Hopkins and American University of Beirut. Moving forward, in addition to our work in Zanzibar, refugee health will be an important part of our efforts. We are partnering with local experts, NGOs and international agencies working towards improving the health outcomes of some of the most vulnerable people on the planet. The goal of this new area, which is a culmination of months of passionate pursuit of excellence by the PGHT students, is aimed at increasing exposure to the grandest challenges of our time, improving our understanding of complex challenges and engaging students in and outside the classroom in areas where they can make meaningful impact. The three PGHT colleagues who participated found the program rich, engaging and uplifting. PGHT will continue to strive for excellence, and will continue to be an active participant in creating high-impact, context appropriate and meaningful solutions to refugee health.

The past quarter also saw further development of our technologies and solutions - in particular the systems level modeling of maternal health in Zanzibar, rapid testing for pre-eclampsia and testing of rapid diagnostic tests. The challenges, ideas and complexities of the field also featured prominently in class discussions, homework, assignments and projects in various classes across BU. Moving forward, we hope that this integration of experience, exposure and engagement, will allow us to reach new partners and benefit from the wisdom, foresight and passion of our students.

As always, we appreciate your support and input and hope that you will continue to be an integral part of the PGHT family.

Yours,

Muhammad

MUHAMMAD H. ZAMAN

HOWARD HUGHES MEDICAL INSTITUTE PROFESSOR

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