The immune system is an essential function that usually saves us from death or severe disease, but unfortunately, as it is often the case, having too much of a good thing can be detrimental. Any infection can lead to sepsis, which is characterized by an overwhelming immune response. Sepsis is associated with fever, elevated heart rate, fast breathing and persistent infection. Severe sepsis leads to organ failure which leads to changes in mental ability, low platelet count, increased urination and weakness. Septic shock, the final stage of sepsis, manifests in the same way plus low blood pressure. When it’s not discovered in time, sepsis can become a slow, painful death and it is one of the most prevalent causes of death in hospitals. In 2019, total hospitalization cost nationwide for sepsis patients was over $62 billion, making it the most expensive condition treated in the US. Moreover, about 85% of sepsis cases and sepsis-related deaths worldwide occur in low- and middle-income countries. Sepsis scientists informed us that as long as diagnosis is achieved within the golden hour (the importance of timely initiation of antibiotic treatment), treatment is quite easy, affordable and straightforward. We thus realized that if we could create a fast diagnosis device for sepsis, death rates would be significantly reduced. I spent seven months conducting research on the International Genetically Engineered Machine (iGEM) competition team at the University of Rochester with the goal of creating a way to continuously monitor the body’s immune response. I did thorough literature review on sepsis biomarkers found in blood and sweat, analyzed the diagnosis cut-offs and checked if there is a correspondence. Once we identified five promising biomarkers, we found in literature aptamers with good affinity and selectivity for the biomarkers of interest. We then determined that reduced graphene oxide (rGO) would be the perfect material for our wearable biosensor sleeve due to its electrical and mechanical properties, as well as being an affordable material to produce (especially using bacteria to reduce it).

Throughout the design of our device, experts from very different fields, from graphene-based biosensor scientists to critical care nurses and sweat sensing experts were consulted and their advice was carefully implemented. We thus had to combine our knowledge in Molecular Biology, Electrochemistry, Physics, Mathematics, Computer Science and more to create a device that took everything into consideration and was at the same time affordable. We also met with educational experts to find the best way in which we can inform the public about sepsis’ relevance, as well as increase synthetic biology awareness and interest. We also worked towards designing a laboratory course which would make biology more accessible to kids on the autism spectrum, because we recognized there is a lack of researchers on the spectrum.

RESEARCH EXPERIENCE

COMMUNITY SERVICE

INTERDISCIPLINARY APPROACH

GLOBAL DIMENSION

ENTREPRENEURSHIP & INNOVATION

We created a set of 15 sepsis facts translated in multiple languages to make sure doctors but more importantly possible patients all around the world are aware of this deadly disease. We also posted many informational sepsis flyers around the medical center and River campus at the University of Rochester. Moreover, we created a virtual 5k initiative to support our sepsis diagnosis device, and participated in the Sepsis Superhero Challenge raising funds for the Sepsis Alliance. Recognizing the importance of science communication to general audience, we organized a symposium where a nurse shared her medical perspective on sepsis diagnosis and treatment challenges, we shared a touching sepsis survivor story video, a volunteer from the Sepsis Alliance talked more about their resources and what others can do to raise awareness of this condition, and then our team presented our diagnosis toolkit and the Ohio State iGEM team presented their creative sepsis treatment plan.

From the beginning, we met with different stakeholders in post-operative care to understand what they want to see from our device. We also visited the ICU and discussed with nurses since they would be the ones putting the sleeve on patients. We also learned from FDA experts what would be the steps to get our device approved and on the market as a diagnostic tool. After learning in what category our device would be, we created an expected cost and made a marketing strategy. Moreover, we are currently participating in the State Finals for the NYS Business Plan Competition, where we created a more complete business plan.

Throughout the design of our device, we talked with iGEM teams from Brazil and Berhampur to understand how sepsis is viewed in their countries and what their greatest needs are. We also talked with sweat sensing experts from Europe, and made sure our design was taking their newest discoveries into consideration. We carefully considered in which areas of the world our device’s implementation would benefit, and we are hoping to use modelling to determine the best placement for our devices based on each hospital’s staff pool and possibilities. We made an effort to globally collaborate with as many teams as possible, to best achieve sepsis awareness increase.

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