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N.I.C.O.L.A.S (Non-Invasive Continuous Optical Lactic Acid Sensor)
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Progress Report 2

1. **Background on the project itself**

   The Non-Invasive Continuous Optical Lactic Acid Sensor (N.I.C.O.L.A.S.) is a smart lactate sensing modality developed for continuous, noninvasive blood lactate level monitoring in clinical settings. It will be a vast improvement on the intermittent blood draws currently employed for blood lactate monitoring due to its ability to sample lactate levels continuously and noninvasively in a small package that will be less resource-intensive on hospitals. Our sensor will utilize near IR spectroscopy (NIRS) and ratiometric analyses to detect fluctuations and alert healthcare professionals of any rapid spikes in lactate levels. This will help healthcare providers better utilize lactate as an early indicator of sepsis, organ failure, and hemorrhage, allowing for earlier preventative intervention in these cases leading to improved patient outcomes. At last reporting, we gave updates on the following fronts:

   - Circuit Troubleshooting (Supply Voltage and LED Pulse Frequency Optimization)
   - Light-Tissue Interactions
   - Phantom Design Requirements
   - Lactate Absorbance Curve
   - Transition from Transmission to Near Infrared Spectroscopy (NIRS)

2. **Achievements since last reporting**

   Since the last report, we have made progress in completing our project. With regards to circuit troubleshooting, we have a functional pulsed current source to drive our LED and a current to voltage converter for the photoconductor. We can clearly view our signal and attenuate by interrupting the beam path. We have also made progress on attaining a full spectrum of lactate. We have gained access to the VINSE space. We have analyzed the spectrum in water, and in other solutions. We have changed our design from transmittance base to a NIRS approach. We have also contacted VAPR, Vanderbilt Antibody and Protein Resource, to see if we could find a compound that could bind to lactate for potential fluorescence analysis.

3. **Problems that have arisen**

   With regard to the circuit, we have had trouble filtering out 60Hz noise in our system. We are currently able to focus on the signal and see the attenuation, but we would like to see our signal without this process. The spectrum of lactate in water gave inconclusive data. This required us to go back into the lab and try to get cleaner spectrums with different solvents.

4. **Work that lies ahead**

   We have a spectrum of lactate, so we will now compare and see how our device behaves at each concentration of lactate in various solutions. We will work on developing LabVIEW programs to record the signal of our data and see if we can do any processing to remove 60 Hz noise. We will also develop a notch filter to see if that is a solution to removing the noise. We will stay in contact with VAPR about possible compounds to tag lactate for detection. A finger clip design for NIRs will

be developed. We also plan to characterize how the LED and photoconductor components interact, especially how angle and distance change the signal output.

5. **Assessment of objectives relative to proposed schedule and budget**
   We should be on schedule for our objective. NICOLAS is supposed to be a non-invasive method to detect lactate. We theorize that we can use NIRS to modify the circuit and meet the proposed schedule and budget. There would be no required change in the materials, but the diode and the photoconductor would be re-arranged, and the microcontroller reprogrammed to analyze the modified Beer-Lambert's Law. Other changes would require a varied voltage source and adjustments in our finger clamp schematics to reflect the change in our circuit. We are still under budget with no foreseen purchases at the moment.