A Low-Cost, Point-of-Care Ammonia Sensor for Urea Cycle Disorder Patients Utilizing Colorimetric Techniques

Long, Mindy (School: Hamilton High School)

Urea cycle disorder (UCD) is a genetic disorder that affects 1 out of 35,000 births in the United States and has a 24% mortality neonatal rate. UCD is characterized by hyperammonemia, which is a condition of fatally high plasma and urine ammonia concentrations. This project seeks to develop a novel, mobile application-based sensor that can obtain ammonia concentration via urine samples at home, saving both time and money, as current methods cost hundreds of dollars and take at least 3 days to return results. Designs of the sensor materials were assembled and tested to obtain a non-degradable yet accurate multi-layered sensor. A mobile iOS application for users was designed to take pictures of the sensor and reference areas and calculate ammonia concentration based on the difference of RGB values, which indicate ammonia absorbance. A reader device, consisting of a simple plastic box with a window for phone placement and 4 white LED lights, was developed to maintain constant illumination of the sensor. After the application was validated with the standard RGB value extraction software, a time-dependent calibration curve was established between RGB absorbance and ammonia concentration and tested to ensure performance. Results were obtained in 8 minutes. The app showed a 98% correlation with standard methods, proving the device accurate to be used in a non-professional setting. This novel, mobile application-based approach to developing a noninvasive sensor costs less than $2 a sensor and can easily be translated and modified to detect other biomarkers such as acetone, which tracks metabolism, opening up the door to more personalized and accessible healthcare.

Awards Won: