Quantifying Enzymatic Activity and pH to Create a Wearable Smart Bandage for Partial-Thickness Burns

Shaik, Sana Afsheen (School: Bentonville West High School)
Rianto, Mairesse (School: Bentonville High School)

Partial-thickness burns make up 85.4% of all clinical cases (Ji et al., 2024). At the same time, those in underrepresented areas display higher burn incidences and are less likely to administer proper first aid (Snelling et al., 2021). We created a smart bandage that uses pH and protease activity to classify the healing cascade stage of partial thickness burns and administer a corresponding treatment, profoundly impacting underserved communities. It includes a colorimetric layer that changes color, from yellow to blue, based on the environmental pH. The color change is recorded with a TCS3200 color sensor. Using our calibration curve with known pH buffers, these raw RGB values can be associated with a specific pH value. Bromothymol and Thymol blue were our pH indicators in the colorimetric layer so the Blue Values have the greatest sensitivity slope, making it the best variable for the calibration curve. An INA219 sensor in the electrode layer of the bandage calculates the change in resistance when adding our proxy enzyme, Bromelain. We found the change in resistance of the electrode layer to have a more negative slope as proteolytic activity increases, recorded by a calibration curve. The processed pH and protease activity values are sent to the Boolean logic model to classify the healing cascade stage and release the specific treatment. We found our model was able to classify and detect a modeled healing cascade in vitro. It was also able to identify the difference from a healing vs infected wound, in vitro, with our proxy skin set up. This project shows the potential for technology in wound care, and can significantly improve the quality of wound care in underserved communities.

Awards Won: