Project Overview: Glucose Colorimetric Paper Test Strips
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Background:
Diabetes is the group of diseases characterized by excessive blood glucose levels due to the body's inability to produce insulin or the lack of proper usage of insulin. Since diabetes is an incurable and chronic disease, daily blood glucose checkups are vital in ensuring well-being and safety. However, it is difficult for many diabetics in developing countries to manage their disease because there are no means to inexpensively and effectively measure their blood glucose levels. Currently, the most prevalent method is to use a glucometer with one-time-use test strips. Glucometers range from $40 to $60[1] and individual test strips cost between $0.40 to $2.00[2]. Type II diabetics who are not on oral medication are recommended to test blood sugar levels at least once a day, and Type I diabetics may need to test up to six to ten times per day[3]. This financial constraint is especially dire in countries like Uganda, where the average income in Kampala, its largest city and second wealthiest district by GDP per capita, is roughly $300 per month[4].

Proposed Solution:
Our project is centered on glucose colorimetric paper test strips and focused on improving the visual accuracy of the blood sugar determination through indicator experimentation. When glucose is introduced to the strips, a color change occurs and indicates the relative blood glucose and diabetic status of the user. Glucose oxidase, the primary glucose reagent in glucometers, will be used in these test strips to produce gluconic acid and hydrogen peroxide. We plan to use indicators such as potassium iodide (using the well-known starch-iodide color change), TMB, and 2,2`-Bipyridine (Fe complex); these indicators can all be used to visually differentiate between different levels of hydrogen peroxide, which should be approximately proportional to blood glucose levels. The glucose oxidase and indicator solutions will be distributed in bottles, from which tests can be conducted dropwise onto strips of A4 copy paper. To complement the colorimetric strips, we hope to create a smartphone application that uses camera input and a color analysis algorithm to determine the glucose level (to a reasonable accuracy) based on the color of the strips. The Uganda Bureau of Statistics shows that 86% of 18-30-year-olds own a smartphone and most Kampala households have access to a smartphone so a mobile app is reasonable[5].

This project is an extension from the first iteration by the 2017 EID group[6]. As an extension to their method, we plan to use a fibermesh membrane to filter out plasma from red blood cells to avoid a red color contamination. We also planned to improve the algorithm to filter out some of the red blood color and lighting by using a small blood sample and white paper as color controls.

[1] https://www.webmd.com/diabetes/qa/how-much-do-glucose-meters-cost
[2] http://www.diabetesforecast.org/2012/jul/the-cost-of-test-strips.html
[3] https://www.diabetesselfmanagement.com/blog/type-1-diabetes-vs-type-2/
[4] https://moodle.cooper.edu/moodle/pluginfile.php/72961/mod_resource/content/1/DiabetesManagement-IntroPresentation-9-6-18-v1.pdf
[5] https://www.ubos.org/onlinefiles/uploads/ubos/2014CensusProfiles/KAMPALA-KCCA.pdf
[6] https://minhtyyufa.wixsite.com/gcubedsolutions