Title: SweatSense: A Sweat-Based Wearable Technology for Diabetes Management During Exercise

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Introduction and Background: About 30% of Canadians live with diabetes or prediabetes.[1] It can be managed with exercise,[2] although exercise-induced hypoglycemia and hyperglycemia are real risks.[3] My dad, a prediabetic, manages his health using DEXCOM G7, which is invasive[4] and expensive.[5]

Innovation: SweatSense is a non-invasive, affordable wearable harnessing eccrine sweat to monitor glucose and other analytes, using colorimetric analyses performed with a smartphone camera.

Procedure: The technology is being developed and tested in three phases. Phase 1: Three colorimetric sensors, detecting glucose, lactic acid, and sodium ions, are being developed on a 100% cotton substrate. Using glucose oxidase (Gox), horseradish peroxidase (HRP), and 3,3′,5,5′-Tetramethylbenzidine (TMB), shades of blue are analyzed for glucose detection. Using Fe(III)-tris (1,10 phenanthroline), weak orange to intense red is analyzed for lactic acid detection. Using potassium chromate and silver nitrate, red to yellow is analyzed for sodium ion detection. Phase 2: Standard solutions of glucose, lactic acid, sodium ion, and pH are individually tested on a substrate to train the machine learning (ML) model for colorimetric analysis. Photos of the substrate, captured after absorption of the target analyte, are used to validate the ML model. Phase 3: The ML model will subsequently be trained for simultaneous sensing of all three biomarkers in triplicates. The resulting data will be interpreted by a separate neural network to produce personalized feedback. The calculated analyte concentrations and generated suggestions will then be communicated to the user using a smartphone app.

Preliminary Results: A convolutional neural network (CNN) was trained with varying pH levels, and an improved CNN was subsequently trained and validated with sodium ion concentrations. The results are very promising with the recent ML model yielding over 90% accuracy over all seven tests.

Conclusion: SweatSense will make glucose-monitoring during exercise comfortable and affordable.

References

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