

SP6* Glucose monitoring: Jerry C. Parker, Ph.D., Anandhi Upendran, Ph.D., University of Missouri

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Significance: Dr. Parker is interim senior associate dean for research and a professor of physical medicine and rehabilitation at the MU School of Medicine. Dr. Parker is also co-director of the MU Institute for Clinical and Translational Science (MU-iCATS) and MU Coulter Translational Partnership Program. Dr. Upendran is a director of biomedical innovation at MU-iCATS. Her research is focused on developing synthetic protocols for large scale production, establishing analytical tools for characterization and validation of the quality controls of different types of nanomaterials per regulatory requirement towards imaging, diagnostic and therapeutic applications [1-4]. With Dr. Uzma Kahn, associate professor of endocrinology, Dr. Upendran and her research team lead the clinical study at University of Missouri.

Disorders of glucose homeostasis, including types 1 and 2 diabetes, as well as gestational diabetes, represent a leading cause of morbidity and mortality worldwide. In the US, an estimated 2-5% of all pregnant women develop gestational diabetes, which can result in significant morbidity to the mother and the fetus if it goes undetected. At the same time, the incidence of diabetes in general has been increasing at a significant rate, affecting nearly 16 million Americans in 2005, and it currently stands as the sixth leading cause of death in the United States (<http://www.cdc.gov/diabetes/>). Diagnosis and therapeutic monitoring of diabetes requires direct measurement of plasma (or blood) glucose. Regardless of the clinical test performed, withdrawal of blood or interstitial fluid is currently required for measurement of plasma glucose levels. Non-invasive measurement of blood or interstitial glucose levels is highly desired, given the large number of diabetics, some of whom must undergo glucose testing several times each day, and it is a critical component of point-of-care diagnostic testing and therapeutic monitoring.

Approach: Over the past decades, MIT Laser Biomedical Research Center (LBRC) has pioneered and significantly advanced instrumentation and methodologies for non-invasive measurement of blood glucose using Raman spectroscopy. Physiological lag between blood and interstitial glucose was modeled and compensated [5]. Robust nonlinear calibration algorithm based on supporting vector machine was developed [6]. Non-imaging optical elements such as compound parabolic/hyperbolic concentrators were integrated into the clinical Raman system for enhanced collection efficiency [7]. The effect of tissue photobleaching on calibration was studied [8]. Wavelength-based algorithm was investigated as a potential miniaturization method [9]. Most recently, new calibration method which requires minimal blood measurement was developed [10]. After these technical improvement, noninvasive glucose instrument went through human volunteer studies at MIT clinical research center. However, the accessible resource at MIT CRC is limited since MIT does not have its own medical school and hospital. The limited number of volunteers with less diversity and more importantly, difficulty to get access to diabetic population were major concerns.

Clinical research center at University of Missouri is fully equipped with more than 400 clinical trials in the process of improving health and quality of life. In collaboration with Drs. Parker and Upendran, LBRC installed glucose instrument in University of Missouri at 2016 April (Fig. 1). After LBRC staff trained Missouri scientists and physicians, Missouri team is independently collecting human volunteer data. Expected results from SP7 include (1) skin-color dependent prediction accuracy, (2) investigation of optimal tissue measurement site, (3) feasibility test with diabetic population. Glucose volunteer study performed in University of Missouri was approved by Institutional Review Boards.

Center Offering:

LBRC has provided NIR-Raman based glucose instrument for this project. Since Missouri team does not have previous photonic expertise, we also provided training in Raman equipment usage. We will further provide chemometric algorithm and assistance in analyzing Raman spectra.

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