Journal of Diabetes Science and Technology
Volume 4, Issue 6, November 2010

ORIGINAL ARTICLES

Technologies for Continuous Glucose Monitoring: Current Problems and Future Promises

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Abstract

Devices for continuous glucose monitoring (CGM) are currently a major focus of research in the area of diabetes management. It is envisioned that such devices will have the ability to alert a diabetes patient (or the parent or medical care giver of a diabetes patient) of impending hypoglycemic/hyperglycemic events and thereby enable the patient to avoid extreme hypoglycemic/hyperglycemic excursions as well as minimize deviations outside the normal glucose range, thus preventing both life-threatening events and the debilitating complications associated with diabetes. It is anticipated that CGM devices will utilize constant feedback of analytical information from a glucose sensor to activate an insulin delivery pump, thereby ultimately realizing the concept of an artificial pancreas. Depending on whether the CGM device penetrates/breaks the skin and/or the sample is measured extracorporeally, these devices can be categorized as totally invasive, minimally invasive, and noninvasive. In addition, CGM devices are further classified according to the transduction mechanisms used for glucose sensing (i.e., electrochemical, optical, and piezoelectric). However, at present, most of these technologies are plagued by a variety of issues that affect their accuracy and long-term performance. This article presents a critical comparison of existing CGM technologies, highlighting critical issues of device accuracy, foreign body response, calibration, and miniaturization. An outlook on future developments with an emphasis on long-term reliability and performance is also presented.

J Diabetes Sci Technol 2010;4(6):1540-1562

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Abbreviations: (CGM) continuous glucose monitoring, (ConA) concanavalin A, (FRET) Förster resonance energy transfer, (GO_x) glucose oxidase, (ISF) interstitial fluid, (NAD) nicotinamide adenine dinucleotide, (NIR) near infrared, (SC) subcutaneous, (SMBG) self-monitoring of blood glucose, (T1DM) type 1 diabetes mellitus, (T2DM) type 2 diabetes mellitus, (TRM) tissue response modifier

Keywords: accuracy, calibration, continuous glucose monitoring, glucose detection, glucose sensors, invasiveness

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