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ORIGINAL ARTICLES

Measurement of Glucose in Blood with a Phenylboronic Acid Optical Sensor

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Abstract

Background:

Current methods of glucose monitoring rely predominantly on enzymes such as glucose oxidase for detection. Phenylboronic acid receptors have been proposed as alternative glucose binders. A unique property of these molecules is their ability to bind glucose in a fully reversible covalent manner that facilitates direct continuous measurements. We examined (1) the ability of a phenylboronic-based sensor to measure glucose in blood and blood plasma and (2) the effect on measurement accuracy of a range of potential interferents. We also showed that the sensor is able to track glucose fluctuations occurring at rates mimicking those experienced *in vivo*.

Method:

In vitro static measurements of glucose in blood and blood plasma were conducted using holographic sensors containing acrylamide, *N*,*N*′-methylenebisacrylamide, 3-acrylamidophenylboronic acid, and (3-acrylamidopropyl) trimethylammonium chloride. The same sensors were also used for *in vitro* measurements performed under flow conditions.

Results:

The opacity of the liquid had no affect on the ability of the optical sensor to measure glucose in blood or blood plasma. The presence of common antibiotics, diabetic drugs, pain killers, and endogenous substances did not affect the measurement accuracy, as shown by error grid analysis. *Ex vivo* flow experiments showed that the sensor is able to track changes accurately in concentration occurring in real time without lag or evidence of hysteresis.

Conclusions:

The ability of phenylboronic acid sensors to measure glucose in whole blood was demonstrated for the first time. Holographic sensors are ideally suited to continuous blood glucose measurements, being physically and chemically robust and potentially calibration free.

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Abbreviations: (3-APB) 3-acrylamidophenylboronic acid, (ATMA) (3-acrylamidopropyl) trimethylammonium chloride, (CLSI) Clinical and Laboratory Standards Institute, (EDTA) ethylenediaminetetraacetic acid, (MBA) *N*,*N*′-methylene bisacrylamide, (PBS) phosphate-buffered saline, (YSI) Yellow Springs Instruments

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