Continuous reagent-free bed-side monitoring of glucose in biofluids using infrared spectrometry and micro-dialysis

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Abstract

Quasi-continuous glucose monitoring has been realised for a bed-side device based on reagent-free transmission spectroscopy of microliter dialysate sample volumes. Aqueous glucose solutions and serum ultrafiltrates were used for in-vitro testing, whereas in-vivo samples were provided by a subcutaneously implanted micro-dialysis probe. Both sample types were transported to a thermostated flow-through micro-cell, housed within the sample compartment of a Fourier-transform mini-spectrometer, by using a programmable fluidic system consisting of a 6-port valve with sample loop and a syringe pump. Different options were implemented for spectral evaluation based on multivariate calibration using either partial or classical least squares. The latter approach includes the additional quantification of most relevant dialysate components such as urea, lactate, bicarbonate and others. Automated operator-free in-vitro operation with reliable glucose quantification over at least 72 hours was tested for analytical performance characterisation. Ex-vivo detection of glucose in combination with micro-dialysis is often hampered by the occurrence of micro-air bubbles, which usually impair the biosensor functionality drastically. Thus, routines for sensitive air bubble detection by infrared spectrometry including automated removal by the fluidic system have been implemented.

Keywords: Infrared transmission spectroscopy; Micro-dialysis; Glucose monitoring; Partial least squares regression, Classical least squares regression