Development of a Flexible Vancomycin Sensor Using A Molecularly Imprinted Polymer Carbon Paste

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Introduction Drug levels in neonates' blood change rapidly. However, frequent blood concentration analysis is not possible due to limitation in blood consumption. This problem can be addressed by developing a method to continuously measure drug concentrations by implanting a fine and flexible sensor subcutaneously, similar to continuous glucose monitoring. In this study, a flexible and fine vancomycin sensor was developed and its performance was evaluated by utilizing a carbon paste with a molecularly imprinted polymer (MIP), which is sensitive to vancomycin.

Method After graft copolymerization of a monomer with an affinity for vancomycin, a crosslinking monomer, and an electron transfer monomer onto the surface of graphite particles in the presence of vancomycin as a template, the treated particles were washed with a sodium chloride solution and distilled water to remove the template. Subsequently, the treated particles were mixed with silicone oil to prepare the MIP-carbon paste (MIP-CP). A 20 mm tip of 0.5 mm diameter tin-plated copper wire was coated with conductive carbon ink, and MIP-CP was applied to the conductive ink. Insulating ink was applied to the bottom 20 mm of the wire to limit the effective area of the electrode to 0.38 cm^2. Differential pulse voltammetry was conducted using this wire electrode as the working electrode in a buffer saline solution containing vancomycin. The correlation between the detected current and the concentration of vancomycin was studied.

Results and Discussion The MIP-CP fixed to the wire electrode did not fall even when strongly rubbed, making it suitable for subcutaneous implantation. The response current from the electrode with fixed MIP-CP increased linearly ($R^2 > 0.99$) with vancomycin concentration (0-40 μM). Non-imprinted carbon paste was prepared using the same procedure as the MIP-CP, except for the omission of the template. The non-imprinted paste exhibited lower sensitivity compared to MIP-CP, indicating that MIP-CP detects vancomycin through the specific interaction between vancomycin and the vancomycin-imprinted cavity on the carbon. Despite some drift in the response current, if the data are calibrated to account for this drifting rate, the sensor is feasible as an implantable TDM sensor.

Keyword Molecularly Imprinted Polymer, Carbon Paste