Disposable Sensor Chips using Molecularly Imprinted Polymers Enables Easy Determination of Blood Level of Drugs

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Background

Area under concentration (AUC) is important factor for TDM of antibacterial drugs but hard to be obtained by the conventional analytical methods which are usually outsourced. We developed disposable sensor chips using molecularly imprinted polymers (MIPs) grafted on carbon particles, which are macromolecules that have been conferred specific binding capacity for a particular target molecules during the synthesis, to detect drugs in real time.

Methods

MIPs of vancomycin or meropenem were grafted on graphite-carbon particles and mixed with silicone oil to make MIP-carbon paste. Three pieces of polyethylene glycol terephthalate (PET) films shown in **Fig 1** was prepared using a cutting plotter and conductive-ink jetting printer. The pieces were attached with cyanoacrylate glue to make the base of the sensor chip and MIP-carbon paste were packed into a hole of the base. The fabricated sensor chip was connected with an electrochemical analyzer and the sample solution of drugs (vancomycin or meropenem) in saline or bovine whole blood was filled in the reservoir of the chip. The relation of the response current of the chip and the drug concentration was analyzed.

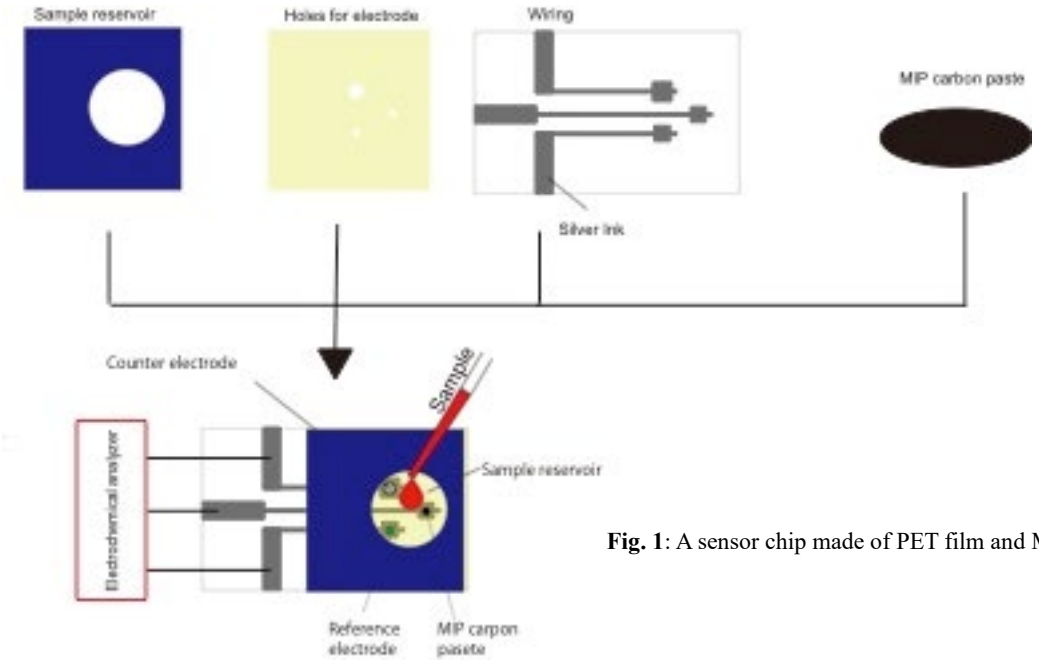

Fig. 1: A sensor chip made of PET film and MIP carbon paste

Results

The relationship between the response current and concentration of each of therapeutic drugs vancomycin, meropenem is shown in **Fig. 2.** The is the high linearity ($r > 0.995$) between the current intensity and the drug concentration covering therapeutic range (Vancomycin: 15-40 μg/mL, meropenem 7-30 μg/mL), although each sensor chip was used for only

one sample. It took only 60 seconds to obtain the output current from the sensor chip.

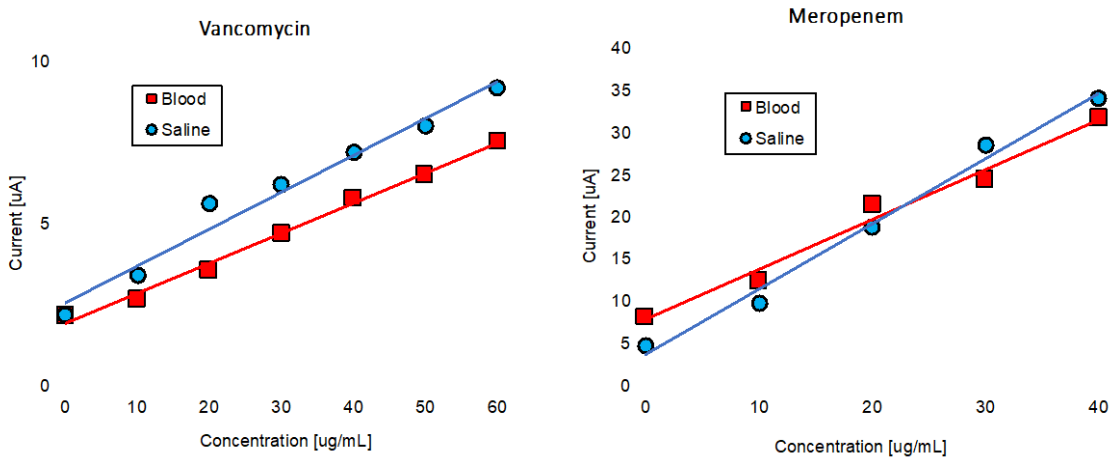

Fig. 2: Calibration curve of vancomycin and meropenem by the respective MIP-sensor chip.

Discussions.

These results demonstrate that the sensor chip enables simple blood concentration measurements of drug concentrations without the need for plasma separation like blood-sugar measurement using glucose sensor chip. The use of a disposable sensor chip is expected to enable "bedside TDM" which allows physicians and pharmacists to quickly determine the optimal timing and dosage for drug administration with considering AUC data. The low cost of the sensor materials and its high durability will decline the hospital's inventory risk.

Conclusion.

The sensor is helpful for especially hospitals in developing countries, which suffer from the spread of resistant bacteria and have difficulty introducing TDM due to the large cost.

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Keywords; Sensor Chips, Molecularly Imprinted Polymer, Point-of-Care, Bedside TDM