Simultaneous and real-time quantification of multiple drugs with a diamond electrode

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To elucidate the mechanisms underlying beneficial and adverse effects of drugs, it is crucial to measure local pharmacokinetics within target organs in real time. At clinical site, multiple drugs are simultaneously used for treatment of a variety of diseases including infection and cancer. In this case, the pharmacokinetics would be complicated because of drug-drug interaction. Therefore, for rational design of multi-agent regimen, it is necessary to develop a sensing system that can track different compounds over time in the target.

In this study, we utilized a needle-type diamond microsensor and established a dual-drug monitoring procedure based on electrochemical method. With the microsensor, we simultaneously detected two antibiotics in vitro, vancomycin and ceftriaxone. These compounds are combined and applied to the patients with meningitis. Initially we analyzed current-voltage property of each drug in PBS. Both antibiotics showed reduction currents in response to negative potential. Second, we analyzed PBS containing both vancomycin and ceftriaxone. In this condition, the detected current is expected to stem from electrochemical reactions of both drugs. To separate individual components, we applied two different pre-oxidation potentials followed by reduction step. This protocol permitted us to measure therapeutic concentration of vancomycin with a time resolution of 10 s in the presence of ceftriaxone. The method described here would be valuable to precisely determine the pharmacokinetics modulated by drug-drug interactions.