**Community Sensors for Monitoring Public Health using Wastewater-Based Epidemiology**

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Wastewater-based epidemiology (WBE) has been shown to be an innovative approach for monitoring drug use in communities by quantifying drug biomarkers in sewage. The approach can also be employed for the analysis of health and disease biomarkers from faeces and urine. Faeces and urine from either humans or animals carry many biomarkers and pathogens, which could enter the sewage system from a carrier of the disease in the community, e.g. patients at hospitals. Those pathogens such as bacteria, viruses and parasites in wastewater can be hazardous to humans and can lead to pathogen epidemic. Infectious diseases require rapid or even real-time detection to assess whether there is a need for the containment of the disease carriers to certain areas and prevent the development of an epidemic. To this end, there is a great need to develop novel analytical tools that are able to rapidly and accurately monitor low levels of biomarkers/pathogens with minimal sample processing by unskilled personnel at the site of sample collection. Emerging biosensing technologies can play a key role in the in situ quantitative analysis of biomarkers and pathogens in sewage due to rapid response times, low cost, minimal sample processing, high data resolution and ability to operate remotely. Community sewage sensors employed to detect biomarkers of health and diseases at a population level have therefore the clear potential to provide real-time data for the assessment of community-wide health [1].

A biosensor is a small device with a biological receptor (e.g. DNA, antibody, protein etc.) that generates an electrochemical, optical, piezoelectric, nanomechanical or mass sensitive signal in the presence of an analytical target. Here, we present a range of community sewage sensors developed to analyse various biomarkers, such as mitochondrial DNA, proteins (e.g. prostatic specific antigen) and drugs (e.g. cocaine) in sewage for monitoring of public health. In particular, a new label-free electrochemical DNA (E-DNA) biosensor was developed, utilizing a custom synthesized ferrocenyl intercalator as a transducer, which allows the detection of human-specific mitochondrial DNA in sewage and signle mismatched basepairs[2]. This novel community sensor could be used to identify potential population biomarkers for the monitoring of public health using wastewater-based epidemiology. Moreover, a novel impedimetric aptamer sensor based on DNA-directed immobilization for rapid detection of cocaine was developed towards evaluation of concaine consumption by analysis of wastewater. The analysis of cocaine in wastewater from weekly sampling in treatment plant shows similar cocaine use trends from that determined with mass spectrometry[3], indicating that the developed cocaine sensors have the potential to evaluate illicit drug use trends but with rapid response times, low cost and even with a potential for the assay in the field. Finally, we will discuss community sensors for the detection of a prostate cancer biomarker (PSA) in wastewater based on a DNA-directed immobilization aptamer sensor[4], which could be potentially used to evaluate the cancer prevalence at the local population level.

**References**

[1] Yang,Z Kasprzyk-Hordern,B., Frost, C.G., Estrela, P., Thomas, K.V. Community sewage sensors for monitoring public health. ***Environ. Sci. Technol***, 2015, 49, 5845-5846.

[2] Yang,Z., Anglès d’Auriac M., Goggins, S., Kasprzyk-Hordern,B., Thomas, K.V., Frost, C.G., Estrela, P. A novel DNA biosensor using a ferrocenyl intercalator applied to the potential detection of human population biomarkers in wastewater ***Environ. Sci. Technol***, 2015, 49, 5609–5617.

[3] Yang,Z., Estrela, P., Castrignanò, E., Frost, C.G., Kasprzyk-Hordern, B. Community Sensors towards Evaluation of Drug Use Trends: Detection of Cocaine in Wastewater with DNA-Directed Immobilization Aptamer Sensors. Submitted 2015

[4] Yang,Z., Kasprzyk-Hordern,B., Goggins, S., Frost, C.G., Estrela, P. A novel immobilization strategy for electrochemical detection of cancer biomarkers: DNA-directed immobilization of aptamer sensors for sensitive detection of prostate specific antigen, ***Analyst***, 2015, 140, 2628-2633.