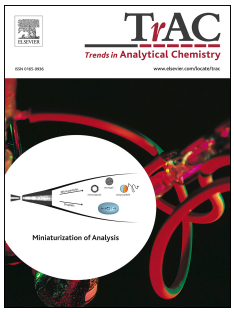
Journal Pre-proof



Biosensors and New Analytical Methods for Wastewater-Based Epidemiology

Zhugen Yang, Damià Barceló

PII: S0165-9936(23)00048-1

DOI: https://doi.org/10.1016/j.trac.2023.116961

Reference: TRAC 116961

To appear in: *Trends in Analytical Chemistry*

Please cite this article as: Z. Yang, D. Barceló, Biosensors and New Analytical Methods for Wastewater-Based Epidemiology, *Trends in Analytical Chemistry*, https://doi.org/10.1016/j.trac.2023.116961.

This is a PDF file of an article that has undergone enhancements after acceptance, such as the addition of a cover page and metadata, and formatting for readability, but it is not yet the definitive version of record. This version will undergo additional copyediting, typesetting and review before it is published in its final form, but we are providing this version to give early visibility of the article. Please note that, during the production process, errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

© 2023 Published by Elsevier B.V.

TrAC Trends in Analytical Chemistry, Volume 162, May 2023, Article number 116961
DOI: 10.1016/j.trac.2023.116961
Journal Pre-proof

Biosensors and New Analytical Methods for Wastewater-Based Epidemiology

Zhugen Yang[1] and Damià Barceló[2]

[1]*Cranfield University, Cranfield, MK43 0AL, UK*
[2]*IDAEA-CSIC and ICRA, Barcelona 08034, Spain*

Wastewater-based epidemiology WBE has shown to be an innovative and promising tool for the estimation of community-wide health such as drugs, alcohol, and tobacco use in the past couple of decades since it was proposed in the beginning of 21 centuries. Since the first report from the Netherland in March 2020 on the presence of viral RNA fragment of SARS-CoV-2 in wastewater, WBE, also namely, wastewater surveillance, has been rapidly emerged as a new public health tool for the monitoring of pathogens to establish the early warning for the pandemic, which can provide the complementary data sets for the clinical testing. For example, viral RNA of SARS-CoV-2 can be monitored in the community at the early stage, effective measures can be taken as early as possible to minimize the pathogen spread.

WBE offers a near real-time and cost-effective evaluation of community-wide diseases (e.g., cancer) or behaviours (such as drug-abuse) patterns, infectious disease (e.g., Covid-19), and antimicrobial resistance, with the potential to influence local, regional or national policy on public health management. Currently, there are more than 60 countries carrying out the regional and national wastewater surveillance programme worldwide to support better management of pandemic.

WBE builds upon on the analysis of sewage biomarkers (e.g., chemicals, biological and genetic materials etc) in a local wastewater treatments plant. Although wastewater is a complex matrix, a range of classical and novel analytical tools have been developed to effectively analysis sewage for WBE. Biosensors have been demonstrated to be powerful tools for both drugs and pathogens analysis alongside with conventional analytical methods. This special issue brought together a set of review papers on recent progress of WBE from highly active and world-leading expertise in analytical chemistry, microbiology, virology, and epidemiology and engineering, and to provide new insights in this field. We have overall gathered 11 articles from diverse research groups worldwide.

For example, Thomaidis et al summarized the commonly used steps (sampling, storage, concentration, isolation, detection) of the analytical protocols for wastewater, and discussed the potential limitations of each stage of the protocols and good practices. They also proposed new methods for the efficient detection of SARS-CoV-2.

Kudr *et al.* highlighted the significance of biosensors in the field of rapid Covid-19 detection and discussed how electrochemical sensors hold promise in the development of rapid diagnostic tools.

Ou *et al.* addressed the relationships between WBE and droplet microfluidics, with an emphasis on pathogen analysis in droplets, which was difficult to treat with typical analytical instruments. They discussed three research problems, including quantitation of pathogen biomarkers in droplets, single-cell analysis in droplets, and living cell biosensors in droplets.

Rahman *et al.* provides an overview of the design and operation principles of nanobiotechnology enabled biosensors, as well as current advances in the application of biosensors for biomarker detection. Furthermore, biosensors for investigation of the SARS-CoV-2 virus were highlighted as they related to the possible increased usage of biosensors for WBE-based monitoring.

Cui *et al.* reviewed the most recent technical advances in Raman biosensors and molecular approaches for phenotypic and genotypic monitoring, with an emphasis on the significance of integrating phenotypic and genotypic analysis via targeted single-cell sorting. They also proposed technology needs

Published by Elsevier. This is the Author Accepted Manuscript issued with: Creative Commons Attribution Non-Commercial No Derivatives License (CC:BY:NC:ND 4.0).
The final published version (version of record) is available online at DOI:10.1016/j.trac.2023.116961. Please refer to any applicable publisher terms of use.

to improve for wastewater surveillance and better inform pathogen and antimicrobial resistance (AMR) management strategies.

Picó *et al.* assessed current achievements in biomarker identification for WBE and analysed the different methodological schemes that have been developed to perform biomarker as well as the most characteristic analytical techniques in each scheme. They also identified the strengths, weaknesses and knowledge gaps of each methodological scheme.

Chio *et al.* outlined the working principle of cucurbiturils -Au nanoparticles (CB-Au NP) nanocomposites including manufacturing, sensing processes, and structure-property correlations, as well as design recommendations and chosen examples of CB-Au NP SERS sensors. The study also discussed recent developments in this field and explored potentials within the framework of WBE.

Saltepe *et al.* concluded the most recent breakthroughs in synthetic biology technologies and highlighted how they enabled the construction of rapid, low-cost, simple-to-use, and field-deployable biosensors for monitoring a wide range of water pollutants and health-related indicators in the environment.

Xie *et al.* provided a comprehensive overview on diffusional microfluidics and their applications in protein analysis, as well as highlights of current breakthroughs in diffusional microfluidics-based analytical methods. Perspectives on the application of diffusional microfluidics in wastewater-based epidemiology were also discussed.

Mahmoudi *et al.* described the theory underlying smart diagnosis of pandemic infectious diseases (PIDs) utilising WBE with the assistance of digital technology, as are the qualities that must be satisfied. Analytical strategies were investigated that are pushing the boundaries of smart sensing and have a great potential for use in the smart diagnosis of PIDs through WBE.

Finally, Pan *et al* summarized the recent development of paper-based analytical devices (PADs) for the diagnosis of both individuals and in population health, by using devices for testing wastewater. Finally, the review also focuses on PADs for the analysis of bacteria and viruses in wastewater, together with a discussion on the future development of PADs for rapid diagnosis and wastewater surveillance for early warning of pandemics.

Journal Pre-proof



https://dspace.org/

Biosensors and new analytical methods for wastewater-based epidemiology

Yang, Zhugen; Barceló, Damià

2023-05-01
Elsevier
https://doi.org/10.1016/j.trac.2023.116961
Yang Z, Barceló D. (2023) Biosensors and new analytical methods for wastewater-based epidemiology. Trends in Analytical Chemistry, Volume 162, May 2023, Article number 116961

Downloaded from a DSpace repository. https://dspace.org/