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Assessment of Current and Future Opportunities of Chemical and Biological Surveillance of Wastewater for Human Health

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Abstract : The SARS-CoV-2 pandemic has catalyzed the rapid adoption of wastewater-based epidemiology (WBE) methodologies both domestically and internationally. To support the rapid scale-up of pandemic-response wastewater surveillance systems, multiple federal agencies (i.e. US CDC), non-government organizations (i.e. Water Environment Federation), and private charities (i.e. Bill and Melinda Gates Foundation) have funded over $220 million USD supporting development and expanding equitable access of surveillance methods. Funds were primarily distributed directly to municipalities under the CARES Act (90.6%), followed by academic projects (7.6%), and initiatives developed by private companies (1.8%). In addition to federal funding for wastewater monitoring primarily conducted at wastewater treatment plants, state/local governments and private companies have leveraged wastewater sampling to obtain health and lifestyle data on student, prison inmate, and employee populations. We explore the viable paths for expansion of the WBE m1ethodology across a variety of analytical methods; the development of WBE-specific samplers and real-time wastewater sensors; and their application to various governments and private sector industries. Considerable investment in, and public acceptance of WBE suggests the methodology will be applied to other future notifiable diseases and health risks. Early research suggests that WBE methods can be applied to a host of additional “biological insults” including communicable diseases and pathogens, such as influenza, Cryptosporidium, Giardia, mycotoxin exposure, hepatitis, dengue, West Nile, Zika, and yellow fever. Interest in chemical insults is also likely, providing community health and lifestyle data on narcotics consumption, use of pharmaceutical and personal care products (PPCP), PFAS and hazardous chemical exposure, and microplastic exposure. Successful application of WBE to monitor analytes correlated with carcinogen exposure, community stress prevalence, and dietary indicators has also been shown. Additionally, technology developments of in situ wastewater sensors, WBE-specific wastewater samplers, and integration of artificial intelligence will drastically change the landscape of WBE through the development of “smart sewer” networks. The rapid expansion of the WBE field is creating significant business opportunities for professionals across the scientific, engineering, and technology industries ultimately focused on community health improvement.

Keywords : wastewater surveillance, wastewater-based epidemiology, smart cities, public health, pandemic management, substance abuse
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