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Editorial: Wastewater-based epidemiology as a tool for monitoring public health

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Editorial on the Research Topic
Wastewater-based epidemiology as a tool for monitoring public health

Wastewater treatment facilities serve a critical role in protecting human and environmental health through removal or inactivation of viruses bacteria pharmaceutical etc. For these reasons wastewater treatment facilities provide important venue for epidemiological investigations of emerging diseases. The usefulness of monitoring wastewater was exemplified during the recent SARS-CoV-2 pandemic. This pandemic caused immeasurable suffering in terms of morbidity, and mortality, and had immense economic impacts in both poor and wealthy countries. It is interesting to note that little is still known about the fate of the SARS-CoV-2 virus along the wastewater path. Particularly, at what point during the treatment does the wastewater best reflect morbidity in a population. Numerous studies showed that vulnerable populations such as those living under poor sanitation or in dense populations were affected disproportionately by this pandemic. This was reflected by the presence of the virus in wastewater. Our lab has recently led a Wastewater-Based Epidemiological (WBE) SARS-CoV-2 surveillance in a number of populations in Israel ranging from towns to cities and small villages (during the last 3 years) (Yaniv et al., 2021a,b, 2022). That study together with others provided further evidence for its importance in tracing pathogens and toxicants as part of WEB. WBE has been implemented since the mid-20th century and is being developed continuously for a variety of purposes, including as a tool for assessing drug consumption, pathogen prevalence (e.g., polio), chemical contaminations, and pollution exposure. This further emphasizes the importance of the continued development and deployment of WBE techniques for public and environmental health monitoring. It is important to note that the use of WBE has many benefits, as it can monitor large populations and has the potential to provide an early-warning platform for spread of diseases or of contaminants. Nevertheless, WBE also has some limitations. These include the lack of sensitive, fast, and cheap detection methods that are required for establishing WBE as a reliable means for public health assessments. On the other end of the spectrum in countries with well-developed vaccination regimes such wastewater monitoring is valuable for assessing the rate of vaccination in the population including vaccination regimes for diseases such as polio, shingles, smallpox etc. This is exemplified in a recent study by Zuckerman et al. (2022) who used a wastewater surveillance study to provide evidence of Polio outbreaks in Jerusalem Israel as did a recent study that detected monkeypox in wastewater (De Jonge et al., 2022). It should further be noted that assessments of these viruses are usually carried out using molecular tools following concentration protocols, techniques that may not be readily available in all countries.

Here we present four studies carried out in various geographic areas each with unique environmental parameters and wastewater treatment facilities that provide an important look at wastewater monitoring as a tool for studying infection routes. Indeed, taken together these studies show the importance of constant monitoring and assessments as well as the implementation of cautionary principles to keep the population free of many waterborne pathogens. In this Research Topic of publications, we provide a number of recent studies from diverse ecosystems showing the importance and usefulness of WEB. One such recent study was carried out in the Ivory coast (Ouattara et al.). These authors showed how waste-water from poorly treated or untreated sewage systems affect the health of a population. The reports of these health effects reported in both city and small towns with poor treatment facilities provide important impetus for the development of reliable waste-water surveillance tools to monitor and assess possible breakouts or pandemics (Ouattara et al.). In a study carried out in Israel, Yaniv et al. compared off grid and on grid communities levels of SARS-CoV-2 using WBE. Yaniv et al. showed that trends in copy numbers were driven by population size and showed that the virus was detected in sewage-impacted environmental waters representing communities with no access to the wastewater grid. Yaniv et al. further reported that the mismatch observed between detected virus and reported cases may have in many cases indicated asymptomatic or "silent" community transmission, under-testing within these communities or a combination of the two. The importance of these findings lay in the suggestion that sewage surveillance, can provide a critical aspect of outbreak surveillance and control in areas with insufficient human testing and off-grid communities. Additional communities where it may be critical to ascertain outbreak dynamics and infection routes are closed communities such as correction facilities, hospitals, and retirement homes. In a publication by Klevens et al. implementation of wastewater surveillance was undertaken for strategic testing of individuals and of isolated COVID-19 cases early in the course of infection, in correctional facilities in Massachusetts. Klevens et al. quantified the correlation of measured COVID-19 cases with facility-level wastewater surveillance and compared them to standard case surveillance in towns in closest geographic proximity to the participating correctional facilities. A Spearman's rank correlation was calculated at each facility to assess agreement between number of town cases and facility resident cases, and between wastewater concentrations and facility resident cases. Their study showed that wastewater surveillance for SARS-CoV-2 provided an additional signal to objectively supplement existing COVID-19 clinical surveillance for the early detection of cases and infection control efforts at correctional facilities.

In addition to wastewater, human stool carried SARS-CoV-2 viruses. Thus, municipal sewage systems, if not properly treated (see also Ouattara et al.), can provide an additional venue for viral spread. Aghababaei et al. reported SARS-CoV-2 viruses in human stool from municipal sewage. These sewage systems may carry stool by infected individuals that can be shed into the system and thus reach wastewater treatment plants (WWTPs). They noted that despite the fact that wastewater treatment facilities serve an important role in protecting downstream human and environmental health through removal or inactivation of the virus, little is still known regarding the fate of the virus along the treatment path. Particularly at the beginning of the process. Therefore, Aghababaei et al. suggested to assess the efficacy of differing WWTP size and treatment processes in viral RNA removal by quantifying two SARS-CoV-2 nucleocapsid (N) biomarkers (N1 and N2) in both the liquid and solids phases for multiple treatment locations from seven coastal New England WWTPs. They found that SARS-CoV-2 biomarkers were commonly detected in the influent, primary treated, and sludge samples (returned activated sludge, waste activated sludge, and digested sludge), but not detected after secondary clarification processes or disinfection phase. They further showed that solid fractions had over a thousand-fold higher concentrations of viral biomarkers than liquid fractions. This suggests considerably higher affinity of the virus for the solid phase. These findings indicate that using a variety of wastewater treatment designs may be more efficient at achieving high removal of SARS-CoV-2 from effluent. These studies emphasize the importance of understanding the dynamics of the SARS-CoV-2 virus in the different phases and different fractions of sewage and wastewater treatment. The Research Topic of studies presented here provide an important step in emphasizing the importance of close continuous WW monitoring that together with the development of proper facilities and treatment routes may reduce future infection rates and morbidity in the population.

Author contributions

AK: Conceptualization, Project administration, Supervision, Validation, Writing—review and editing. EK-W: Conceptualization, Writing—original draft, Writing—review and editing. KY: Conceptualization, Writing—review and editing.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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