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Viewpoint

Preventing Scientific and Ethical Misuse of Wastewater Surveillance Data

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Sanitation is a cornerstone of healthy communities and sustainable development. In recent decades, opportunities for wastewater to serve a more aspirational role in society have grown, for example wastewater surveillance activities for public health. Wastewater surveillance utilizes measured concentrations of chemical and biological constituents of raw wastewater to infer information about the contributing community. The practice of using wastewater to gain information on the health status of the contributing population is referred to as wastewater-based epidemiology (WBE). Use of this surveillance tool is growing exponentially, and during the COVID-19 pandemic scientists globally used wastewater to understand COVID-19 infection trends. Given the ongoing enormous economic and health impacts of COVID-19 and the pitfalls associated with clinical testing,[1] WBE has been key to informing pandemic response during this public health emergency.[2] As a consequence of the more widespread use of this wastewater surveillance tool, the ethics surrounding how the tool is used has entered the public discourse. As scientists, engineers, policy makers, funding agencies, and utilities explore the opportunities for wastewater surveillance, it is critical that we engage with social scientists, public health researchers, communities, and public advocacy groups and train researchers to consider techno-social sensitivities[17] such as individual privacy and ownership of bodily waste.

Wastewater surveillance predates COVID-19, and the tool has previously been applied to surveil populations for other infectious diseases including polio,[3] hepatitis,[4] and salmonellosis,[5] and also for information on narcotics usage[6] and alcohol

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consumption.[7] Studies have even proposed identifying chemicals present in wastewater to infer characteristics of the contributing population, including whether people speak English, are educated, are poor, are disabled,[8,9] and the degree to which populations experience depression.[10] Some authors suggest wastewater surveillance may be used to replace census efforts.[8]

Wastewater surveillance studies have been applied at different spatial scales spanning from large wastewater treatment plants that serve 1 million people to individual buildings that house 10s to 100s of people. Studies have focused on prisons[11] and on time periods of festivals[12] to assess illicit drug usage associated with targeted populations.

We are struck with both the potential promises and perils of wastewater surveillance. Regardless of application, this approach requires careful ethical scrutiny, including consideration of the size and vulnerability of the populations subject to wastewater surveillance, and the type of information sought. Many applications of wastewater surveillance are justifiable and ethical. For example, use during the pandemic has largely been accepted as an emergency action to mitigate the spread of a dangerous pathogen. Determining the ethics of using wastewater for COVID-19 surveillance can be guided by WHO and country-level guidelines.[13] Additionally, ethical guidelines on the application of wastewater surveillance may also be drawn from a published report by Prichard et al.[14]

However, we caution that characterizing individuals based on aggregate measurements is an ecological fallacy.[15] In reading some of the referenced papers that infer socio-economic and demographic characteristics from wastewater, the reaction of one of the authors of this viewpoint was that using biomarkers to characterize various community attributes served to eliminate them as an individual: "*As someone who is Latinx and has trouble being represented in official surveys, it is disheartening to have my identity further erased.*" Another reaction from an author questions the true affordability of products that give rise to specific biomarkers used to infer aspects of socio-economic status: "*I have been low income my whole life, and the one factor that undoubtedly demonstrates my experience is a lack of stability. The biomarkers that are supposed to capture "lack of stability" are related to nutrition and pharmaceuticals and personal care products (PPCP). However, I question the affordability and accessibility of these PPCPs to routinely treat/cope with distress.*" While these reactions are from individuals, they represent a cross-section of the community whose characteristics or lived experiences are inconsistent with, or absent from, the justifications for proposed model(s). We, as a community, need to be sensitive to such reactions.

As we explore these opportunities, it is critical we recognize that many natural scientists and engineers do not have extensive training or experience to navigate ethical issues associated with wastewater surveillance. However, social scientists and public health professionals have vast experience in this area, and should be engaged from start to finish in wastewater surveillance research and publications. As institutional review boards (IRB) are charged with minimizing risks to individuals, addressing wastewater surveillance ethical considerations across broad communities will require moving beyond this institutionally required structure. Researchers contributing to wastewater surveillance will likely need to pursue respectful stakeholder engagement and extensive outreach in communities to support knowledge sharing and to minimize and resolve conflicts related to study objectives, study design, and data use and communication. We believe that most studies are done in good faith with aspirations for positive societal impact. Beyond good intent, however, our research community has an obligation to conduct ethical research as well as recognize and address systematic racism in research.[16] By neglecting these ethical considerations, we risk eroding public trust in the application of wastewater surveillance.

Ultimately, wastewater surveillance provides an opportunity for wastewater to play a new, dynamic role in the protection of public health in our communities. Additional ethical guidance related to the protection of privacy, balancing individual rights with population interests, and the communication and use of findings will be needed.[13,14] We should proactively engage scholars from across disciplines and constantly and methodically consider the broader implications of our work. Done properly, we have the potential to prevent scientific and ethical pitfalls while simultaneously advancing our role in the protection of our communities and our environment.

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Notes

The authors declare no competing financial interest.

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