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Short Communication

Early SARS-CoV-2 outbreak detection by sewage-based epidemiology

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HIGHLIGHTS

- Detect early presence of virus in sewage.
- SARS-CoV-2 has been isolated from the faeces.
- Sampling, preserving and processing samples are critical issues.
- Consider a SARS-CoV-2 sewage-monitoring plan.

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ABSTRACT

Sewage can be used to determine the scale of COVID-19 outbreak. Sewage Epidemiology or Waste Based Epidemiology (WBE) approach has been successfully used to track and provide early warnings of outbreaks of pathogenic viruses such as Hepatitis A, Poliovirus and Norovirus. In untreated wastewater COVID-19 (excreted via faeces then introduced to wastewater) can survive from hours to days. Detection of COVID-19 can be carried out with nucleic acid-based polymerase chain reaction (PCR) assay, used for confirmation of COVID-19 patients around the globe. New cheaper and faster monitoring tools are being developed to detect Covid-19 in wastewater by biosensors, ELISA, or paper-based indicator methods. This will allow to reveal true scale of Covid-19 outbreak associated with population link to a specific wastewater treatment plant.

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1. Discussion

As of April 20th, 2020, the SARS-CoV-2 has been responsible for more than 2,411,500 infections and 165,300 deaths worldwide (<https://coronavirus.jhu.edu/map.html>). Current efforts are mainly focused on preserving health services from collapse by adopting non-pharmacological interventions to mitigate the transmission of the novel coronavirus disease (COVID-19). However, much attention should be paid to future outbreaks of the disease, assuming that unnoticed, asymptomatic cases of coronavirus infection could be an

important source of contagion (Day, 2020) and that reliable screening and rapid detection of all new cases is challenging.

Interestingly, concentrations of different substances in wastewater has provided qualitative or quantitative information on the activity of inhabitants within a given wastewater catchment, mainly about the usage of drugs. Recently, emerging potential applications have been proposed in the field of infectious diseases (Choi et al., 2018).

SARS-CoV-2 has been isolated from the faeces and urine within three days of infection (Holshue et al., 2020; Chen et al., 2020). In a study evaluating virus dynamics in Zhejiang province at China, it was observed that the median duration of virus in stool was 22 days (interquartile range 17–31 days), which was significantly longer than in respiratory airways (18 days) and serum samples (16 days) (Zheng et al., 2020). Considering that the virus may survive for up to several

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days out from the human body, its measurement in wastewater could provide a valid and complementary tool for preventive tracking and diagnosing COVID-19 across communities. Crucially, according to a recent study, SARS-CoV-2 RNA was detected in samples of sewage before any case was reported, suggesting that virus monitoring could be feasible before cases are documented through the health surveillance system (Medema et al., 2020). Another recent study in wastewater samples collected in Paris from March 5 to April 72,020 revealed that the increase in SARS-CoV-2 genome units was followed by the increase in the number of fatal cases registered at both the regional and national levels (Wurtzer et al., 2020).

Sampling, preserving and processing samples are critical issues and detecting the virus at low concentrations in sewage may result challenging. Some initial data suggest that nucleic acid-based polymerase chain reaction (PCR) test and one-step RT-droplet digital PCR may shed light on virus quantification. These approaches have high specificity and sensitivity, but they are time-consuming and demand skilled personnel and a long period of data processing and analysis which are not ideal when real-time monitoring is pretended. Interestingly, paper analytical devices have emerged as valid platforms for the cost-efficient detection of nucleic acid sequences of viruses and other pathogens. The whole procedure can be done through simple folding of a paper-based device in several ways without the need of power supply or other additional tools, thus overcoming many of the time-consuming limitations of PCR tests. Such a tool was successfully employed in the diagnosis of malaria from whole blood, providing a higher-quality and faster precision diagnosis than PCR (Reboud et al., 2019). However, there are still several challenges to face including the need of developing standardized and reliable virus quantification protocols, the limited data available for conducting a quantitative microbial risk assessment for SARS-CoV-2 exposure pathways, determining the half-life of viable SARS-CoV-2 in sewage and establishing a sampling plan and schedule that is representative of the population among others. Still, we don't know how much virus an individual sheds with faeces. In addition, as global resources are limited this approach should be carefully explored before application according to its location facilities and the implementation of other measurements.

However, we consider that early coronavirus detection in sewage may represent a non-invasive warning approach to alert communities to new COVID-19 infections, given that most people will not be tested. More than a dozen research groups worldwide are currently evaluating this tool as a way to predict future coronavirus outbreaks. We think such a strategy should be explored at a "micro" context, according to the available resources, especially on nursing homes and long-term residential facilities, where the virus can spread rapidly provoking devastating consequences in persons with chronic underlying medical conditions (McMichael et al., 2020). For example, more than 14,000 elderly people using public, concerted and private nursing homes throughout Spain have died in the context of the health crisis caused by COVID-19 infection. Besides, it may also be used at a "large" context, neighborhood, cities or regions. The early presence of virus in sewage may help to adopt more focalized and balanced social and health measures. In summary, we beg healthcare authorities to consider a SARS-

CoV-2 sewage-monitoring plan according to their sewage treatment facilities. An early intervention may have important effects on health systems and saving lives as well as may facilitate decisions to restrict the movements of that local population. This may be a game-changer in early detection of COVID19 outbreaks and in restarting parts of the economy more quickly and safely.

We declare no competing interests.

CRediT authorship contribution statement

Gorka Orive: Investigation, Writing- original draft. **Unax Lertxundi:** Investigation, Writing- review & editing. **Damia Barcelo:** Investigation, Writing- review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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