World Health Organization
REGIONAL OFFICE FOR **Europe**

SUMMARY REPORT

EXPERT CONSULTATION ON PUBLIC HEALTH NEEDS RELATED TO SURVEILLANCE OF SARS-COV-2 IN WASTEWATER

VIRTUAL MEETING, 30 NOVEMBER 2020

euro.who.int

World Health Organization

REGIONAL OFFICE FOR **Europe**

Expert consultation on public health needs related to surveillance of SARS-CoV-2 in wastewater

Summary report

**Virtual meeting
30 November 2020**

ABSTRACT

This report summarizes the findings of the *Expert consultation on public health needs related to surveillance of SARS-CoV-2 in wastewater* that was organized by the WHO European Centre for Environment and Health on 30 November 2020 in a virtual format. It aimed to support Member State authorities by facilitating exchange on the use, usefulness and limitations of SARS-CoV-2 surveillance in wastewater from a public health perspective, based on practices and experiences emerging in countries. Surveillance of SARS-CoV-2 RNA in wastewater can provide important complementary and independent information in public health decision-making in the context of the pandemic. The health sector is the end-user of the information and therefore needs to take the lead in designing surveillance programmes, merging and linking the data with other surveillance platforms, and coordinating interpretation and communication of the findings.

Keywords

CONTENTS

Background and introduction

Environmental surveillance of pathogens in wastewater is a proven concept in public health surveillance. In the context of the COVID-19 pandemic, an increasing number of countries in the WHO European Region and elsewhere have adopted sewage surveillance programmes for detecting SARS-CoV-2 RNA in communal wastewater and sludge. Such surveillance is used as early warning for the emergence and re-emergence of SARS-CoV-2 circulation in communities, the identification of hot spots, tracking back of first occurrences of the virus by investigating conserved wastewater samples for SARS-CoV-2 RNA, and ascertaining the appearance of mutations and variants.

Complementary to clinical surveillance of COVID-19, information on spatial and temporal trends of SARS-CoV-2 RNA in wastewater can be used to inform public health decisions and manage the response to the pandemic. Utilizing such data from wastewater surveillance, however, entails consideration of a range of aspects beyond confirming the technical and scientific applicability of such an approach. There is a need to develop a common understanding and confirm the needs and requirements of the health sector as the "end user" of such surveillance data. This will help in shaping wastewater surveillance programmes that are driven by public health needs and provide supporting information to produce an ample picture of occurrence of infection and facilitate decisive public health actions.

Building on the outcomes and recommendations of a first consultation on 23 July 2020[1] and the considerations presented in WHO's scientific brief on the status of environmental surveillance for SARS-CoV-2,[2] the WHO European Centre for Environment and Health (ECEH) and the European Commission jointly organized a second expert consultation, which took place in a virtual format on 30 November 2020. It aimed to support Member State authorities by facilitating exchange on the use, usefulness and limitations of SARS-CoV-2 surveillance in wastewater from a public health perspective, based on practices and experiences emerging in countries. In particular, the objectives of the consultation were to:

- review the scientific evidence on the environmental presence of SARS-CoV-2;
- share emerging experiences of using data from wastewater surveillance in national COVID-19 surveillance and response strategies, both at community/municipality level and in specific settings (e.g. hospitals, schools, transport hubs);
- develop a better understanding of public health needs and requirements for the use of such data, including triggers that may link wastewater surveillance to decision-making in terms of public health measures;
- identify criteria on where and how the approach might complement and integrate with established public health surveillance;
- consider the feasibility of and possible barriers to scaling up wastewater surveillance at community/municipality level and in specific settings in view of available institutional, laboratory and financial capacities at national and local levels;

[1] Rapid expert consultation on environmental surveillance of SARS-CoV-2 in wastewater: summary report. Copenhagen: WHO Regional Office for Europe; 2020 (https://www.euro.who.int/en/health-topics/environment-and-health/water-and-sanitation/publications/2020/rapid-expert-consultation-on-environmental-surveillance-of-sars-cov-2-in-wastewater-summary-report-2020, accessed 19 January 2021).

[2] Status of environmental surveillance for SARS-CoV-2 virus. Scientific brief. Geneva: World Health Organization; 2020 (https://www.who.int/publications/i/item/WHO-2019-nCoV-sci-brief-environmentalSampling-2020-1, accessed 19 January 2021).

- discuss opportunities arising from a more systematic use of wastewater-based epidemiology and surveillance in the context of the European Green Deal with special emphasis on the revision of the European Union legislation on wastewater;
- identify country support needs in the short- and long-term.

The consultation was attended by 50 experts representing ministries of health, national public health and environment institutions and academia from 11 Member States of the WHO European Region (Austria, Belgium, France, Germany, Hungary, Ireland, Italy, Luxembourg, the Netherlands, Norway and Spain) and other countries (Australia and Canada); the European Commission (Directorate-General (DG) for Health and Food Safety, DG for Environment and DG Joint Research Centre (JRC)); the United Nations Economic Commission for Europe; and the WHO Regional Office for Europe and headquarters (see Annex 1 for the list of participants).

Welcome and setting the scene

Oliver Schmoll, Programme Manager for Water and Climate at WHO ECEH moderated the meeting.

Catherine Smallwood, Senior Emergency Officer, WHO Regional Office for Europe, welcomed the participants to the meeting on behalf of the Regional Emergency Director. She noted that efforts up to now have been primarily research-driven and it is time to shift the focus from "what" can be done towards "how" to apply research findings and lessons learned into practice to get tangible public health benefits. It is important to discuss the added value and challenges of using wastewater surveillance data in public health decision-making and targeting resources efficiently, so as not to distract efforts of other ongoing routine clinical surveillance programmes. She observed that the meeting was timely and brought together key actors to discuss specific aspects related to strengthening wastewater surveillance. She thanked the European Commission for mutual cooperation and co-hosting the meeting.

Ranieri Guerra, WHO Assistant Director-General, highlighted the growing evidence on the usefulness of surveillance of SARS-CoV-2 in wastewater as an additional tool in overall public health surveillance and in enhancing early warning capacity. He noted that wastewater surveillance will be useful in tracking resurgence of virus circulation and disease trends in the community, including during additional waves of COVID-19 infections. Mr Guerra also stressed the need to standardize surveillance strategies and methodologies, considering the feasibility and resource implications of scaling up wastewater surveillance programmes, as well as taking concerted actions throughout the WHO European Region.

Wolfgang Philipp, Head of Unit, Health Security and Vaccination, DG for Health and Food Safety, European Commission, reiterated that while surveillance of SARS-CoV-2 in wastewater will not replace clinical surveillance, it is a promising complementary approach. It could potentially become a very informative tool to track not only the extent of COVID-19 infections, but could also be used in other situations when such surveillance is important. From the past 10 months of experience in responding to the COVID-19 pandemic, it has become clear that countries need to improve national capacities on preparedness for future crises, risk management and outbreak control. On 11 November 2020, the European Commission took its first steps towards building a European Health Union – outlining a comprehensive framework to address health crises, which aims to set strong requirements on data reporting, to improve evidence from surveillance and to strengthen the mandate of the European Centre for Disease Prevention and Control for enhanced public health surveillance, early detection and effective national and local response actions.

Michel Sponar, Deputy Head of the Marine Environment and Water Industry Unit, DG for Environment, European Commission, stressed that there were signals for the presence of SARS-CoV-2 RNA in pre-pandemic wastewater samples. He highlighted that a European Union (EU) umbrella project was already established for harmonizing methodology of sampling and analysis of wastewater for public health purposes, which is led by JRC and jointly implemented with several European partners. Mr Sponar indicated the possibility of including additional requirements for wastewater monitoring in the ongoing revision of the EU Urban Wastewater Treatment Directive. In order to do so, it would be critical to develop an understanding of when and where to test, in what frequency for different settings and how to interpret data. He acknowledged intensified collaboration with WHO ECEH in this area of work and that the meeting would contribute to building a bridge between wastewater operators and the health sector, which need to come together to successfully implement this joint undertaking.

Mr Schmoll, reviewed the basic concept, history and development of surveillance of SARS-CoV-2 in wastewater. Wastewater data mirrors the disease pattern occurring in a given setting. Complementing the clinical surveillance of COVID-19, information on spatial and temporal trends of SARS-CoV-2 RNA in wastewater can be used to inform public health decisions and manage the response to the pandemic. Utilizing such data from wastewater surveillance, however, entails consideration of a range of aspects beyond confirming the technical and scientific applicability of such an approach. Since the first WHO ECEH-hosted expert meeting on 23 July 2020, which focused on the "data supply" side, substantial progress has been made. This includes dynamic research, uptake of wastewater analysis in routine surveillance programming in several countries, development of technical guidance on wastewater monitoring, establishing the COVIDPoops19 dashboard showcasing wastewater surveillance activities across the globe and increased media attention on the subject. There is a need to develop a common understanding and confirm the needs and requirements of the health sector as the "end user" of such surveillance data. This will help in shaping wastewater surveillance programmes that are driven by public health needs, and provide supporting information to produce an ample picture of occurrence of infection and take decisive public health actions.

Bernd Manfred Gawlik, Project Manager, Water and Marine Resources Unit, DG JRC, and

Trudy Higgins, Marine Environment and Water Industry Unit – Seconded National Expert, DG for Environment, informed participants of the main achievements and experiences gained under the EU umbrella study for SARS-CoV-2 sewer surveillance that currently covers 25 countries. The project serves as an exchange platform of local and national initiatives and strives to address emerging questions related to the feasibility of wastewater surveillance (e.g. logistics, costs and benefits), validity of sampling approaches, quality assurance, and guidance and support to operators and public health professionals to institutionalize such a surveillance system across EU countries.

Subsequently, the meeting was organized as a series of four moderated dialogues, each structured around a set of guiding questions (see Annex 2 for the meeting programme and sets of guiding questions). The dialogue themes were as follows:

- Decision support and integration with existing surveillance frameworks;
- Sampling strategy and validity of data;
- Ethical considerations and public communication;
- Financial considerations and approaches in the long-term.

The dialogues were moderated by Bruce Gordon and Kate Medlicott, Head and Team Leader (respectively) of the Water, Sanitation, Hygiene and Health Unit, WHO; Francesca Racioppi,

Head of WHO ECEH; and Mr Gawlik. The main outcomes of the discussions are summarized below.

Moderated dialogues on health sector perspectives on surveillance of SARS-CoV-2 in wastewater

Decision support and integration with existing surveillance frameworks

The participants shared examples of usage of sewerage data for tracking circulation of SARS-CoV-2 and discussed how information from environmental surveillance and clinical testing was used in an integrated manner to support credible decisions on public health interventions in response to positive detection of SARS-CoV-2 RNA in the community or in specific locations. Participants also discussed challenges and barriers in introducing or scaling up environmental surveillance.

Participants confirmed that surveillance of SARS-CoV-2 RNA in wastewater is an objective instrument for generating important complementary information in public health decision-making. Wastewater surveillance helps minimize possible bias that is inherent in clinical testing: while everybody uses the toilet several times a day and sheds SARS-CoV-2 RNA when infected, not everybody gets tested clinically for COVID-19. Whereas wastewater surveillance does not require the active involvement of the population, it still provides information about SARS-CoV-2 RNA circulation among the population in the sampling area. At the same time, participants stressed that wastewater surveillance cannot replace clinical testing and case detection of COVID-19, but can complement it.

The strength of such wastewater surveillance is particularly clear in situations where clinical evidence is absent, limited or delayed. Sewerage surveillance seems to work best when used as a relative tool in tracking transmission trends in communities. Because it is difficult to quantify the number of people affected in one area based on the number of genomes detected in wastewater, at present it appears to be a less useful tool in making conclusions about the absolute numbers of infected people in a given setting.

While the approach appears to be useful in revealing an increase in cases, it appears less predictable for tracking a decrease in cases due to the long virus shedding time after clinical symptoms have passed. These characteristics need to be considered in interpreting data and justifying possible public health interventions.

Potential use cases of wastewater surveillance in different phases of the COVID-19 pandemic

Wastewater surveillance for SARS-CoV-2 RNA, including for the appearance of mutations and variants, can be employed as a population surveillance tool in different contexts and stages of an outbreak. The discussion focused on the question of what phases of the COVID-19 pandemic wastewater surveillance is most useful in. Use cases for informing public health action were demonstrated for three different phases:

- In the alert phase of the pandemic when virus circulation is low, wastewater surveillance is useful for early detection of the introduction of the virus in the community, thereby revealing "surprises" and trends in prevalence. Such information could be used to take early response measures to limit further spread in the community. While several countries confirmed wastewater testing as an effective early warning system, others expressed some doubt about the added value, referring to the short time window between the detection of SARS-CoV-2

RNA in sewage samples and the detection of symptomatic cases by the public health surveillance system.

- In the pandemic phase when virus circulation is high, information generated by wastewater surveillance is considered "nice to have" for decision-makers and governments to monitor the effect of lockdown measures or provide support to the argument for such measures. In addition, the monitoring of wastewater of specific settings harbouring many people or accommodating vulnerable population groups (e.g. schools, health-care facilities or elderly care homes) may be a further use case in this phase for confirming presence or absence of cases and looking at trends in SARS-CoV-2 circulation in students, teachers, patients, staff and visitors.

- In the transition or interpandemic phase when prevalence is low or absent, the focus of wastewater surveillance is on the confirmation of the absence or resurgence of COVID-19 in certain areas of the city or community. In this case, SARS-CoV-2 could become one among several bacterial and viral indicators in what could be established as a long-term population surveillance tool. Such integration of wastewater surveillance into existing surveillance frameworks requires close coordination and collaboration across different sectors and levels.

Stakeholder coordination and responsibilities

Meeting participants emphasized that as the end-users of the information, public health departments should be responsible for and lead the set-up, coordination and implementation of wastewater surveillance programming to ensure a health-led and integrated decision-making process. Support from and close coordination with key stakeholders, such as environment and water departments, regional/local authorities, wastewater operators/associations and laboratories is essential to achieve the best possible outcomes. Establishing close dialogue among all parties involved about the strengths and weaknesses of wastewater testing may foster better understanding and increase acceptance towards scaling-up.

National coordination by a multidisciplinary team was implemented in several countries (e.g. Australia, Belgium, Luxembourg and Spain) and was recommended to secure the necessary funding, to assign clear responsibilities (for different activities, such as sampling, analysis, evaluation, risk communication and response actions) and to bring together all data generated through local and subnational initiatives to allow for consistent comparison of results. Coordination at international levels (e.g. EU) appears to be promising, particularly regarding methodological aspects.

Use of surveillance data in decision-making

Reporting and management of data has been highlighted as another important component for public health decision-making. Data need to be generated and used at the local level in a timely fashion; the analysis and interpretation of results remain very context-specific tasks. Central online dashboards can be used to collect, display and integrate environmental and clinical surveillance data at subnational and national levels. Such dashboards can support internal communication among health authorities and communication with the general public. In this context, it is important that data from environmental and public health surveillance are displayed using comparable spatial resolutions so that associations may be derived and suitable actions implemented based on consistent data.

Meeting attendees highlighted the need to develop evidence-informed algorithms for decision-making. To facilitate the decision-making process, some countries (e.g. Austria, Belgium, Italy, Luxembourg and the Netherlands) have made an attempt to integrate different surveillance indicators (e.g. epidemiological data from clinical testing, data from sewer monitoring and

projections of the evolution of cases according to scenarios) into a composite indicator to support health decision-making processes. The open question, however, remains how to formulate alert thresholds (RNA levels) that would indicate "critical" change in a given setting and trigger public health action. For example, Hungary uses log-based viral RNA concentration categories and considers a change by one log level as significant for triggering further public health actions; for an indication of resurge, the first confirmed positive wastewater sample is considered indicative.

Additional challenges

Meeting delegates reported a range of challenges in the context of decision support and integration of SARS-CoV-2 RNA testing in wastewater with existing surveillance frameworks. These challenges include a lack of resources for regular monitoring; inclusion of un-sewered sanitation systems in surveillance programming; and the time gap between the sampling and the availability of test results, which do not allow early warning and taking response measures in timely manner. The following section will address in more detail some of the technical issues related to the organization of wastewater sampling and testing.

Sampling strategy and validity of data

In this session, discussions mainly focused on aspects related to the criteria for determining appropriate sampling frequencies and sites. It also addressed the requirements for quality control and confirming the validity of data on SARS-CoV-2 RNA in wastewater to justify public health interventions.

Sampling sites

Sampling sites need to be selected carefully, in particular when resources are limited and not every wastewater treatment plant and/or every sub-catchment of a sewer network can be tested. Under these circumstances, it appears reasonable to select sub-catchments hosting the greatest number of people for testing. The number of inhabitants has been a main selection criterion, mentioned by several countries (e.g. Austria, Belgium, Germany, Hungary and Luxembourg). Sampling locations need to cover a large enough population to allow for detection, but no minimum size of catchment has been reported so far. Experts also mentioned the selection of study areas because they were most affected in previous waves of COVID-19.

Sampling type and frequency

Different sampling strategies are used for different use cases of wastewater surveillance of SARS-CoV-2. In designing the sampling strategy, it is important to define the coverage area and required sampling frequencies and procedures.

The sampling frequency depends on the intended use of the data. While daily sampling has been suggested as ideal, in practice wastewater is being sampled around once or twice a week. Such weekly frequency provides sufficient data to obtain an informative picture on the ground to follow trends in the local context. Some participants suggested that the sampling frequency should be more than once per week, in particular if the surveillance objective is early warning. Further evidence is needed regarding the intervals of sampling and testing for different use cases, as well as on detection limits.

A composite sample (e.g. 24 hour flow proportional sampling at the inlet of wastewater treatment plants) is preferred over a single grab sample. This produces more representative results as compared to reliance on grab sampling, which may easily miss positives. Some

delegates, however, highlighted challenges, including the lack of auto-samplers to collect 24 hour composite samples and the demands of transporting samples within 24 hours after sampling, especially in smaller, more remote communities.

Several factors can impact the informative value of a wastewater sample, including dilution by rain in combined sewers, dilution by discharges of wastewater from commercial or industrial enterprises, ingress of extraneous water, length of the sewage network and number of connections upstream of the sampling point, and presence or absence of pumping stations. The dilution of human wastewater by other sources requires normalization of the data when observing trends in virus RNA concentration, for example by flow correction for faecal load. In Austria, for example, concentrations are converted to population normalized loads, which allows tracking of temporal developments of virus concentrations as well as investigation of spatial differences. Because the characteristics of each sanitation system are unique, normalization of samples should be context specific and at present cannot be generalized at country or particularly global level.

Comparability and quality of data

Meeting participants emphasized the need to harmonize sampling and testing protocols and procedures for the interpretation of laboratory data to improve quality and cross-comparability of analytical results between different laboratories. In doing so, further research is needed on the effectiveness and validation of testing methods (e.g. sensitivity and specificity, positive and negative predictive values). From a public health decision-making perspective, to justify possible interventions, reproducibility and repeatability of sampling results are of more importance than their accuracy.

Such harmonization initiatives could also be coordinated at the international level. Brief information was provided about the global collaborative network on wastewater-based epidemiology for COVID-19, which was established to coordinate and promote the efforts of research groups working in this field, to harmonize and validate methodologies, and to facilitate collaboration and data-sharing (e.g. the COVIDPoops19 dashboard). Within the context of the EU umbrella study, participants discussed the creation of a protocol of equivalence whereby a set of performance criteria for several already existing and comparable methods would be developed that allows for the comparison of alternate methods. The establishment of proficiency testing programmes will be useful in the European Region to evaluate the performance of wastewater testing.

Ethical considerations and public communication

In this part of the consultation, the participants focused dialogue on ethical issues, sensitive points that require attention and communicating information to the public.

Respecting ethical and professional standards

Wastewater surveillance is an integral part of public health surveillance and thus should adhere to the same ethical principles, as laid down in the 2017 *WHO guidelines on ethical issues in public health surveillance*.[3] Existing ethical and professional standards apply, and it is necessary to adopt a precautious approach on how results are interpreted and communicated to the general

---

[3] WHO guidelines on ethical issues in public health surveillance. Geneva: World Health Organization; 2017 (https://www.who.int/ethics/publications/public-health-surveillance/en/, accessed 19 January 2021).

public. It is important to improve the understanding of public health professionals about the limitations of wastewater surveillance and empower them on the ethical use of data.

Instead of testing individuals, surveillance of SARS-CoV-2 RNA in wastewater offers the advantage of pooling information on several hundred or thousand people in one sample. However, ethical issues may arise when monitoring smaller communities or sub-catchments in larger cities that are predominantly inhabited by socially disadvantaged or ethnic minority groups, or in specific settings (e.g. elderly care homes or schools). Precise spatial analysis and geolocation of (positive) samples may lead to risk of stigmatization of certain population groups covered under surveillance. It is therefore advisable to not publicly release such information and to balance individual rights with community protection and interests.

In accordance with the 2017 WHO guidelines, the values and concerns of communities should be considered in planning, implementing and using surveillance data. Those implementing wastewater surveillance programmes, some of whom may be inexperienced in working with public health relevant data, are encouraged to integrate the key principles and requirements of these guidelines into national standards/regulations framing wastewater surveillance activities and to implement them in practice, taking into account local context. For example, the Canadian Water Network developed a guidance document in 2020[4] addressing the ethics and communication of specific aspects related to wastewater surveillance. It aims to prevent the social stigmatization of the affected community by securing identifiable data; increasing understanding of ethical considerations and codes of conduct by environmental science investigators who may initiate wastewater investigations and the public health community; and effectively communicating data to relevant target audiences. Within the EU, the General Data Protection Regulation[5] also needs to be considered. In Luxembourg, for example, the Ministry of Health and the National Ethics Commission ensure appropriate information management to avoid stigmatization and protect individuals' rights.

Public communication

Maintaining public trust is an essential public health function. Poor communication of data to the public undermines public confidence and thereby reduces the effectiveness of public health measures. Effective public health communication is simple and clear to avoid potential misinterpretation, fits the local culture and considers the interests of all involved parties (e.g. patients and wastewater operators). The usage of uncertain signals from wastewater surveillance for public health messaging and recommendations poses a challenge for the managing authority. Analysing, interpreting and communicating the results within responsible authorities and to the general public should follow a precautious approach to avoid stigmatization of population groups.

Several countries established public dashboards. For example, in Hungary, clinical and wastewater surveillance data are analysed and published online by the responsible national authority on a weekly basis in the form of colour-coded maps showing the presence of SARS-CoV-2 RNA in wastewater (by concentration categories – low, moderate, elevated and high) and the COVID-19 trend in the population (decreasing, stagnating, increasing). The sewage monitoring data is used to warn the public in the service area that transmission is increasing in their community. Such information dashboards, if paired with clear public health advice and

---

[4] Ethics and communications guidance for wastewater surveillance to inform public health decision-making about COVID-19. Waterloo: Canadian Water Network; 2020 (https://cwn-rce.ca/wp-content/uploads/COVID19-Wastewater-Coalition-Ethics-and-Communications-Guidance-v4-Sept-2020.pdf, accessed 19 January 2021).

[5] EU General Data Protection Regulation (Regulation (EU) 2016/679). Brussels: European Commission; 2016 (https://ec.europa.eu/info/law/law-topic/data-protection/data-protection-eu_en, accessed 29 January 2021).

guided by ethical concerns, help to increase public awareness and adherence to local quarantine rules and hygiene advice.

Raw data should only be available for decision-making or research purposes to avoid misinterpretation, as the interpretation of raw data by non-experts can be misleading or incorrect.

Financial considerations and approaches in the long-term

The added value, costs, logistics, laboratory capacities and predicted lifetime of a wastewater surveillance programme for SARS-CoV-2 are key considerations for decision-makers in setting up, maintaining and financing such programmes.

Financial considerations

An online survey conducted among countries participating in the EU umbrella study showed a broad range of cost categories associated with surveillance of SARS-CoV-2 in wastewater. A first estimate indicates that sampling a wastewater treatment plant twice per week amounts to average costs of approximately €25 000 per year. Belgium estimated the cost to be €1.5 million per year to keep up their monitoring programme for 42 wastewater treatment plants covering a large proportion of the Belgian population; these estimates cover costs for sampling, transport of samples, laboratory analysis and associated human resources. Spain estimated the costs at €200–240 per sample. In Luxembourg, minimum costs are expected to be in the range of €12 000–15 000 per week if information on COVID-19 prevalence is updated three times per week.

Although these figures on required financial resources appear high at first glance, they may not be unaffordable in well-resourced settings, particularly when included in long-term programming and integrated with other wastewater sampling purposes. It is important to stress, however, that the situation in low-resource settings may look very different and that the uptake of wastewater surveillance programmes must not divert resources away from clinical testing and other essential public health responses and the provision of essential water and sanitation services.

In assessing the financial resource requirements for establishing and maintaining wastewater surveillance programmes, the costs of sampling, laboratory analyses and data interpretation should also be compared to avoided costs to society by taking timely public health action; such costs, however, are much more difficult to estimate. A further aspect of the discussion is related to the question of who should bear those costs. Wastewater operators, so far, have been supporting sampling programmes and providing additional data, although they had no legal responsibility to undertake and/or cover the cost of monitoring of SARS-CoV-2.

Long-term approaches to wastewater surveillance

Experiences with surveillance of other microorganisms and pathogens in wastewater, such as poliovirus and antimicrobial resistant bacteria, have shown that such programmes can provide effective and timely information at the population level. Several countries (e.g. Austria, Belgium, Luxembourg and the Netherlands) highlighted the potential of wastewater surveillance to become a routine monitoring instrument for SARS-CoV-2 in the post-pandemic phase, with reduced geographic coverage and sampling frequency in low or no prevalence periods.

Establishing sentinel (city) programmes, which are tested regularly to detect potential re-emergence of the disease, including the appearance of new mutations and variants, was suggested as a potential way forward. Surveillance of SARS-CoV-2 could be integrated and strengthened alongside other already existing environmental surveillance programmes for enteric viruses, poliovirus, emerging chemical agents or antimicrobial resistant organisms. Wastewater

surveillance systems and wastewater-based epidemiology in this context have the potential to become standard instruments.

Conclusions and ways forward

"Everyone uses a toilet but not everyone gets tested". This quote by a participating expert summarizes in one sentence the strength of surveillance of SARS-CoV-2 in wastewater.

Surveillance of SARS-CoV-2 RNA in wastewater can provide important complementary and independent information in public health decision-making in the context of the pandemic, alongside other information from clinical testing, among others. It is, however, not a replacement for clinical testing.

Wastewater surveillance is a relative tool to observe trends and not an absolute tool to make conclusions about prevalence of COVID-19 in the community. It has a particular strength as a "secondary tool" to detect the virus in the absence of clinical evidence, or as one participant stated: "We look for surprises".

Wastewater surveillance can serve different purposes in different phases of an epidemic. It allows for context-specific approaches, ranging from monitoring circulation in urban agglomerations to tracking hot spots in sub-catchments or finding the unexpected in the tail-end of the epidemic (i.e. when clinical testing tends to drop). The selection of the study areas, sampling locations and frequencies depend on the use case.

The health sector is the end-user of the information and therefore needs to take the lead in designing surveillance programmes, merging and linking the data with other surveillance platforms, and coordinating interpretation and communication of the findings. This can be enhanced by having effective two-way communication between those who perform the sampling and analyses of the limitations and strengths of available methods and the end-users.

A strong and responsive (local/regional/national) coordination model is essential, involving service providers, environmental/wastewater and health departments, in accordance with established mandates (i.e. beyond the current "good will and solidarity" phase we are in). Such coordination is important to gain the best possible return from the investment made.

Comparability of results between different laboratories still remains an issue but the development of sampling and laboratory protocols at the national or international level, or a protocol of equivalence, introducing performance criteria for reference methods, offer possible solutions.

While wastewater surveillance has the potential to spatially pinpoint groups of infected individuals or vulnerable settings for COVID-19, it requires observance of ethical guidelines and effective communication approaches to release potentially sensitive health-related information.

In public communication, positive findings of SARS-CoV-2 RNA in wastewater should not be used in isolation, but together with health data, in order to provide balanced and reliable information. Public dashboards can contribute to keeping awareness and vigilance levels high in the general population – as a means for influencing personal behaviours, if information is paired with public health advice in response to the findings.

Costs of SARS-CoV-2 surveillance in wastewater as a secondary tool might be a burden to low-resource settings, but seem to be rather manageable in high-resource settings, in particular when it is integrated into existing environmental surveillance programmes for other microorganisms and emerging hazards. It is an important moment to join efforts towards developing integrated

surveillance programmes, build capacities for wastewater-based epidemiology and advocate for inclusion of wastewater surveillance in the investment priority.

In terms of follow-up, it was suggested that an editorial group be established to develop "questions and answers" to be published on the internet addressing high-priority issues, which would provide important complementary information to support public health decision-making.

Moreover, the need for regular discussion and exchange of experience, in similar formats as during this expert consultation, was highlighted as crucial to further support health authorities in Member States in weighing the pros and cons of establishing surveillance programmes for SARS-CoV-2 in wastewater and to properly utilize such complementary approaches during the COVID-19 pandemic and beyond.

Annex 1: List of participants

Temporary advisers

Bambury, Niamh
Health Service Executive
Dublin, Ireland

Bennett, Charlene
Senior Technical Officer National Virus Reference Laboratory
University College Dublin
Dublin, Ireland

Böttcher, Sindy
Robert Koch Institute
National Reference Centre for Poliomyelitis and Enteroviruses
Berlin, Germany

Cauchie, Henry-Michel
Luxembourg Institute for Science and Technology
Environmental Research and Innovation Department
Belvaux, Luxembourg

Connell, Jeffrey
Assistant Director National Virus Reference Laboratory
University College Dublin
Dublin, Ireland

Cotter, Suzanne
Health Service Executive
Health Protection Surveillance Centre
Dublin, Ireland

Cunliffe, David
Government of South Australia
SA Health
Health Regulation and Protection
Adelaide, Australia

de Roda Husman, Ana Maria
National Institute for Public Health and the Environment
Centre for Infectious Disease Control
Environmental Department
WHO Collaborating Centre on Risk assessment of Pathogens in Food and Water
Bilthoven, The Netherlands

Diedrich, Sabine
Robert Koch Institute
National Reference Centre for Poliomyelitis and Enteroviruses
Berlin, Germany

Fanoy, Ewout
Municipality of Rotterdam
Department of Public Health
Rotterdam, The Netherlands

Gonzalez, Santiago
Ministry of Health
Water Quality and Environmental Risks
Environmental and Occupational Health
Directorate of Public Health, Quality and Innovation
Madrid, Spain

Hrudey, Steve E.
University of Alberta
Faculty of Medicine and Dentistry
Division of Analytical and Environmental Toxicology
Department of Laboratory Medicine and Pathology
Edmonton, Canada

Jordhøy, Fredrik
Norwegian Institute of Public Health
Department of Zoonotic, Food- and Waterborne Infections
Oslo, Norway

Kuchling, Sabrina
Austrian Agency for Health and Food Safety (AGES)
Division of Data, Statistics and Risk Assessment
Department of Statistics and Analytical Epidemiology
Graz, Austria

La Rosa, Giuseppina
National Institute of Health
Section of Water Quality and Health
Rome, Italy

Lesenfants, Marie
Sciensano
Directorate of Epidemiology and Public Health
Epidemiology of Infectious Diseases
Brussels, Belgium

Lock-Wah-Hoon, Jerome
National Institute for Public Health and the Environment
Centre for Infectious Disease Control
Environmental Department
WHO Collaborating Centre on Risk assessment of Pathogens in Food and Water
Bilthoven, The Netherlands

Lucentini, Luca
National Institute of Health
Section of Water Quality and Health
Rome, Italy
Medema, Gertjan
KWR Water Research Institute
WHO Collaborating Centre on Water Quality and Health
Nieuwegein, The Netherlands

Mouly, Damien
Public Health France
Regional Office – Occitanie
Tolouse, France

Oberacher, Herbert
Medical University of Innsbruck
Institute of Legal Medicine and Core Facility Metabolomics
Innsbruck, Austria

Palau, Margarita
Ministry of Health
Water Quality and Environmental Risks
Environmental and Occupational Health
Directorate of Public Health, Quality and Innovation
Madrid, Spain

Pándics, Tamás
National Public Health Center
Department of Public Health Laboratories
Budapest, Hungary

Vargha, Marta
National Public Health Centre
Budapest, Hungary

Wester, Astrid Loise
Norwegian Institute of Public Health
Department of Bacteriology
Oslo, Norway

Wintgens, Thomas
RWTH Aachen University
Faculty of Civil Engineering
Institute for Water and Environmental Engineering
Aachen, Germany

Wolf-Ott, Florian
Oberflächengewässer
Umweltbundesamt
Vienna, Austria

Yamada, Ami
Ministry for Solidarity and Health
Health Crisis Centre
Paris, France

European Commission

Gawlik, Bernd Manfred
DG Joint Research Centre
Directorate Sustainable Resources
D2 Water and Marine Resources
Ispra, Italy

Higgins, Trudy
DG for Environment
Directorate Quality of Life
C2 Marine Environment and Water Industry
Brussels, Belgium

Langer, Julia
DG for Health and Food Safety
Directorate Public Health
C3 Health Security and Vaccination
Luxembourg

Philipp, Wolfgang
DG for Health and Food Safety
Directorate Public Health
C3 Health Security and Vaccination
Luxembourg

Sponar, Michel
DG for Environment
Directorate Quality of Life
C2 Marine Environment and Water Industry
Brussels, Belgium

United Nations Economic Commission for Europe

Nikiforova, Nataliya
Secretariat to the Protocol on Water and Health
Environmental Affairs Officer
Geneva, Switzerland

World Health Organization
Headquarters

Diop, Ousmane
Surveillance, Labs and Data
Scientist
Geneva, Switzerland

Fontana, Luca
Strategic Health Operations
Consultant
Geneva, Switzerland

Gordon, Bruce
Water, Sanitation, Hygiene and Health
Coordinator
Geneva, Switzerland

Guerra, Ranieri
Assistant Director-General
Geneva, Switzerland

Medlicott, Kate
Water, Sanitation, Hygiene and Health
Technical Officer
Geneva, Switzerland

Montgomery, Maggie
Water, Sanitation, Hygiene and Health
Technical Officer
Geneva, Switzerland

Pavlin, Boris
Health Emergency Information and Risk Assessment
Epidemiologist
Geneva, Switzerland

Peron, Emilie
Public Health Intelligence, Risk Assessment and Dissemination
Epidemiologist
Geneva, Switzerland

Van Eije, Karin
Emerging Diseases and Zoonoses
Technical Officer
Geneva, Switzerland

Regional Office for Europe

Mook, Piers
Infectious Hazard Management
Technical Officer
Copenhagen, Denmark

Racioppi, Francesca
European Centre for Environment and Health
Head of Office
Bonn, Germany

Rashford, Adrienne
Country Health Emergency Preparedness & IHR
Team Lead
Copenhagen, Denmark

Saxentoff, Eugene
Vaccine-preventable Diseases and Immunization
Scientist
Copenhagen, Denmark

Schmoll, Oliver
European Centre for Environment and Health
Water and Climate
Programme Manager
Bonn, Germany

Shinee, Enkhtsetseg
European Centre for Environment and Health
Water and Climate
Technical Officer
Bonn, Germany

Smallwood, Catherine
Emergency Operations
Senior Emergency Officer
Copenhagen, Denmark

Secretariat

Baumann, Philip
ICT Specialist
Bonn, Germany

Rhein-Hubert, Andrea
Programme Assistant
Water and Climate
Bonn, Germany

Rapporteur

Schmiege, Dennis
University of Bonn
Bonn, Germany

Annex 2: Programme and guiding questions

14:00 – 14:15	**Welcome and opening remarks**
	Catherine Smallwood, Senior Emergency Officer, WHO Regional Office for Europe
	Ranieri Guerra, WHO Assistant Director-General
	Wolfgang Philipp, DG for Health and Food Safety, European Commission
	Michel Sponar, DG for Environment, European Commission
14:15 – 14:35	**Setting the scene**
	Background, state of discussion and objective of the consultation *(Oliver Schmoll)*
	Main achievements and learnings of the European Union umbrella study *(Bernd Manfred Gawlik and Trudy Higgins)*
14:35 – 15:40	**Moderated dialogue on perspectives of the health sector in relation to surveillance of SARS-CoV-2 in wastewater**
	Please consult the "Guidance notes for participants" for details on the format of the session and prepare accordingly.
	Introduction to the session *(Oliver Schmoll)*
	Dialogue round 1. Decision support and integration with existing surveillance frameworks *(Moderated by Bruce Gordon with inception intervention by David Cunliffe)*
15:40 – 15:50	**Health break**
15:50 – 16:50	**Moderated dialogue** *continued*
	Dialogue round 2. Sampling strategy and validity of data *(Moderated by Kate Medlicott with inception intervention by Gertjan Medema)*
	Dialogue round 3. Ethical considerations and public communication *(Moderated by Francesca Racioppi with inception intervention by Steve Hrudey)*
	Dialogue round 4. Financial considerations and approaches in the long-term *(Moderated by Bernd Manfred Gawlik with inception intervention by Thomas Wintgens)*
16:50 – 17:00	**Summary conclusions and way forward**

Guiding questions

1. Decision support and integration with existing surveillance frameworks

– In what phases of the COVID-19 pandemic is wastewater surveillance most useful? What are the "use cases" in terms of conditions and settings where such surveillance adds value to public health decision making? Possible applications include:

- Confirmation of (the absence of) virus circulation and early warning of resurges in communities.
- Identification of hot spots in community/city areas.
- Monitoring of specific settings (e.g. hospitals, care homes, transport hubs).

– How can information from environmental surveillance and from clinical testing be collected, analysed and reported in an integrated manner to best support credible decisions on public health interventions?

– Which roles and responsibilities are assigned? Which mechanisms exist to translate the intelligence gathered through environmental surveillance into possible public health action?

– Which experiences have emerged in relation to communication and decision-making chains between public authorities responsible for environmental surveillance and those in charge of the public health response?

– Please share examples of usage of sewerage data for tracking circulation of COVID-19 and for detecting cases or hot spots at city level. Please also share examples of public health action taken in response to positive detections of SARS-CoV-2 RNA in the community or specific locations (e.g. launching and lifting restrictions).

– What challenges and barriers do you see in introducing or scaling up environmental surveillance? Please share examples of cases where such surveillance wasn't considered of added value, including the underpinning rationale.

2. Sampling strategy and validity of data

– Different use cases for wastewater surveillance require different sampling frames. What are the criteria for determining appropriate sampling frequencies and locations/sites?

– How to formulate RNA levels, and changes thereof, that indicate "critical" change in a given setting and may trigger public health action?

– What are the requirements on quality control and validity of wastewater data to justify public health interventions?

– What will be the impact of vaccination on wastewater surveillance and what are the implications for wastewater-based epidemiology?

3. Ethical considerations and public communication

– What ethical considerations need to be observed and how can they be addressed?

– Are there any critical/sensitive points that require attention (e.g. risk of stigmatization of communities in areas with positive findings)?

– How and at what level should data be displayed? Who should operate such information system? Who should have access to this information?

- How should communication to the public be organized?

4. Financial considerations and approaches in the long-term

- What are the costs associated with wastewater surveillance programming? Who should bear the costs?

- What is an appropriate lifetime of a wastewater surveillance programme for SARS-CoV-2?

- Do you see a need to survey SARS-CoV-2 in the post-pandemic phase and can this be done by a wastewater-based approach?

Is the establishment of a permanent sentinel system a perspective for your local context, for example by strengthening and integrating multiple aspects of wastewater-based epidemiology (e.g. poliovirus, human enteric viruses, antimicrobial resistant organisms, chemical pollutants)?

THE WHO REGIONAL OFFICE FOR EUROPE

The World Health Organization (WHO) is a specialized agency of the United Nations created in 1948 with the primary responsibility for international health matters and public health. The WHO Regional Office for Europe is one of six regional offices throughout the world, each with its own programme geared to the particular health conditions of the countries it serves.

MEMBER STATES

Albania
Andorra
Armenia
Austria
Azerbaijan
Belarus
Belgium
Bosnia and Herzegovina
Bulgaria
Croatia
Cyprus
Czechia
Denmark
Estonia
Finland
France
Georgia
Germany
Greece
Hungary
Iceland
Ireland
Israel
Italy
Kazakhstan
Kyrgyzstan
Latvia

Lithuania
Luxembourg
Malta
Monaco
Montenegro
Netherlands
North Macedonia
Norway
Poland
Portugal
Republic of Moldova
Romania
Russian Federation
San Marino
Serbia
Slovakia
Slovenia
Spain
Sweden
Switzerland
Tajikistan
Turkey
Turkmenistan
Ukraine
United Kingdom
Uzbekistan

World Health
Organization
REGIONAL OFFICE FOR **Europe**