CORRESPONDENCE

Research Letter

SARS-CoV-2 Crisis Management With a Wastewater Early-Warning System in the Bavarian District of Berchtesgadener Land, Germany

In this case report set in Berchtesgadener Land we present the successful integration of regionwide geo-referenced wastewater monitoring for SARS-CoV-2, which aims to detect any changes to the local infection process at an early stage and has been used by the local crisis team since November 2020 to manage the situation comprehensively.

The European Commission recommended to its member states to establish blanket wastewater monitoring in March 2021 (1).

The aim was—by considering viral load in wastewater and officially notified new infections with COVID-19—to visualize the current situation on a central digital dashboard, in order to draw conclusions about local central foci of viral entry into the sewer system and, on the basis of these insights, to limit the spread of SARS-CoV-2 by means of targeted measures.

Methodological approach

Since SARS-CoV-2 is excreted by infected people in their stools in the initial days after symptoms develop (but also if the infection is asymptomatic) (2), it is possible to capture the extent of the infection process by means of CoV-2 biomarkers for entire residential areas by analyzing wastewater, independently of people's participation in individual testing (3). In order to ensure that the sampling is as comprehensive as possible, but also ensure swift sample collection, transfer, analysis, and notification, wastewater specimens were taken (by staff in the municipal sewage plants) in the early hours of the morning, twice every week, in nine municipal sewage works as a mixed sample over a period of four hours and additionally directly from the sewers, from three sampling points as a qualified sample (mixed specimen/

FIGURE

Reported new infections in 7 days (as notification data from the Robert Koch-Institute) and SARS-CoV-2 biomarker results in wastewater for Teisendorf with affiliated districts (population 8 100) as sliding average of the mean of three genes. The following four genes were quantified: nucleocapsid gene N, replicase polyprotein (Open Reading Frame) gene ORF, and RNA dependent RNA-polymerase gene, envelope protein gene E (included in moving average).

sample consisting of ≥ 5 specimens; time period ≤ 2 hours). Altogether 100 141 residents in the rural district were included in this way, which corresponds to 95% of the total population. The analysis was confirmed by literature and database searches (4) while adhering to quality controls (5). The samples were cooled and sent overnight to the Water Technology Centre (TZW) in Karlsruhe, where they were immediately centrifuged in order to separate out solid substances. PEG precipitation was used to concentrate the virus in the supernatant (liquor), and viral nucleic acids were isolated in an automated extraction and cleaned up. Four specific SARS-CoV-2 genes were identified by digital droplet PCR and quantified as biomarkers. A result was categorized as positive and subsequently quantified if at least two genes were detected by PCR. The results of the wastewater samples were reported to the crisis team with a maximum delay of 48 hours.

Wastewater monitoring as an innovative diagnostic instrument

The measured biomarkers in wastewater in the period from December 2020 to April 2021, shown as a sliding average and as individual results, reflected changes in the infection process, apart from one event in early December 2020 (*Figure*). Because of the rapid increase in findings in early December, cluster follow-ups were initiated and outbreak events owing to private parties were identified in one district. The assumption is that visitors from the neighboring rural district attended, which makes it difficult to allocate/assign case numbers. Because of notably more wastewater findings, targeted individual tests were initiated once again, which resulted in the containment of clusters in individual municipalities. Notably increasing biomarker results in early March 2021 in the Teisendorf municipality (*Figure*), for example, prompted the crisis team to initiate additional and preventive wastewater screening in different districts and subsequently to training sessions and administration of rapid antigen tests at a major employer's base. The result in the afflux/intake of the Teisendorf wastewater treatment plant (WWTP) on 3 March 2021 was 31 CoV-2 biomarker gene copies/mL and indicated an increase in infections. On the same day, 85 CoV-2 biomarker gene copies/mL were measured in a district that discharges into the Teisendorf WWTP. This high result confirmed a pronounced local infection event, which was confirmed by cluster follow-up for infected people in one street in this district. At the start of the following week, the results in this district had dropped to 31 CoV-2 biomarker gene copies/mL and in the Teisendorf WWTP they had dropped to 7 CoV-2 biomarker gene copies/mL, which indicated a clear fall in infections that was confirmed by falling case numbers.

The detection limit of 1 genome copy/mL improved over the data collection period from a differentiation of about 10 infected people in every 10,000 residents to 2 infected people among 10,000 residents.

A further example of the crisis team acting preventively is Piding municipality. After clearly rising biomarker findings in

January 2021, the health office contacted several larger enterprises. In collaboration with their occupational health services, hitherto undiscovered and asymptomatic COVID-19 cases were identified, and further spread of the infection was stopped in a timely fashion; in addition to general hygiene training, a testing strategy using rapid antigen tests was established.

Conclusions

Integrating a quantitative wastewater early-warning system enabled a trend analysis in the municipalities under study that anticipated the clinical case numbers by 7–10 days. As infected persons may move between municipalities (owing to visits and work), it is possible that biomarker results do not correlate with new infections (in this sense one could refer to “false positive” peaks). The concept can be used as a template for other municipalities, but ultimately also be applied at state level and at national level at the required degree of detail. From a public health perspective it makes sense to enshrine wastewater surveillance in law, as a cost effective and blanket complementary measure accompanying individual testing.

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Conflict of interest statement

The authors declare that no conflict of interest exists.

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References

1. EU Kommission: Commission recommendation on a common approach to establish a systematic surveillance of SARS-CoV-2 and its variants in wastewaters in the EU. C(2021) 1925 final.
2. Zheng, S, Fan J, Yu, F, et al.: Viral load dynamics and disease severity in patients infected with SARS-CoV-2 in Zhejiang province, China, January-March 2020: retrospective cohort study. *BMJ* 2020; 369: m1443.
3. Mao K, Zhang H, Yang, Z: Can a paper-based device trace COVID-19 sources with wastewater-based epidemiology? *Environmental Sci Technol* 2020; 54: 3733–5.
4. Stange, C, Ho J, Tiehm A: Nachweisverfahren und Relevanz von SARS-Coronavirus-2 in der Wasserwirtschaft. *Korrespondenz Abwasser* 2021; 68: 29–39.
5. Otto J, Jurzik L, Schneider M, et al.: Entwicklung und Validierung von molekularbiologischen PCR-Methoden zum quantitativen Nachweis von hygienerelevanten Bakterien und Viren im Wasser. *DVGW energie/wasserpraxis EWP* 10/2015: 58–62.

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