WASTEWATER-BASED SURVEILLANCE FOR PUBLIC HEALTH

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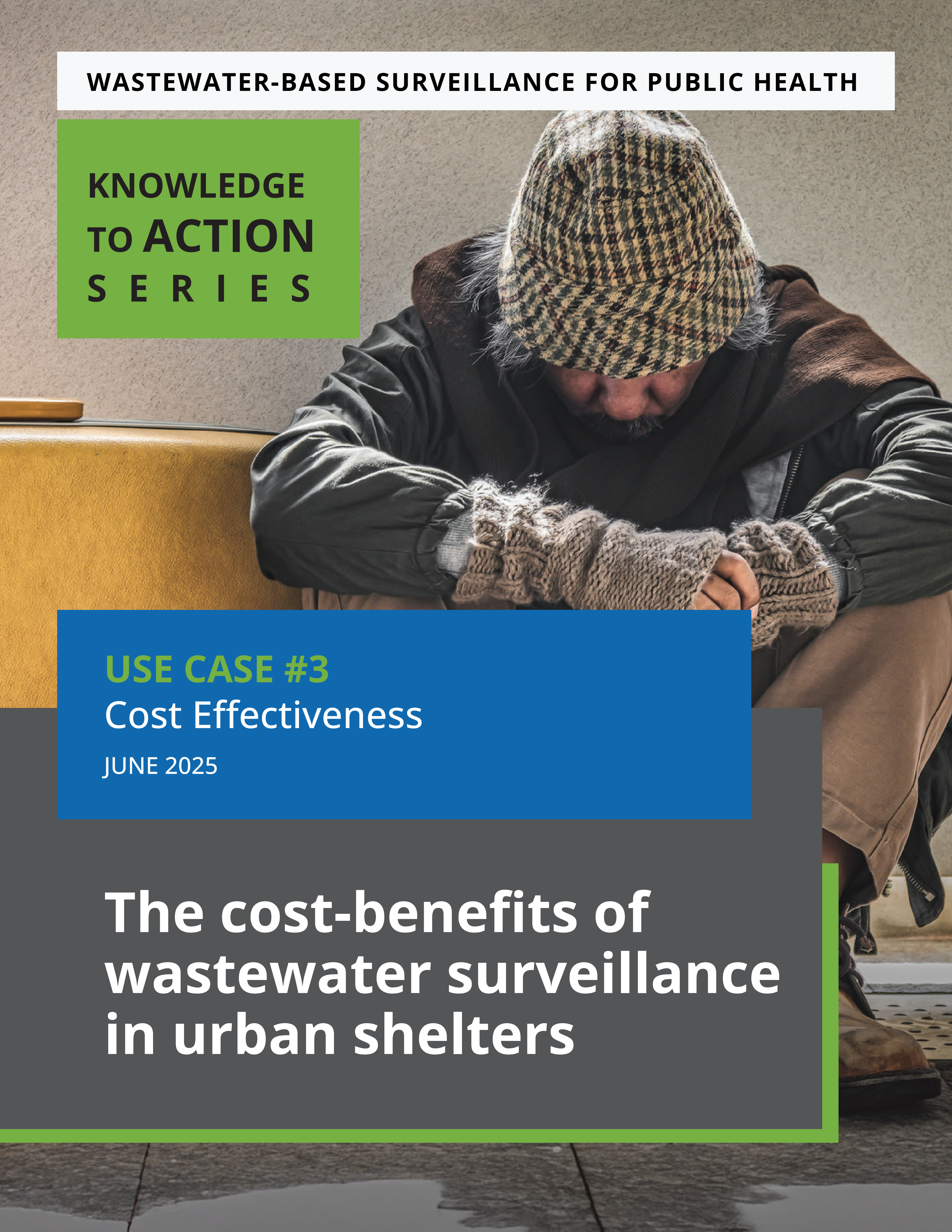

USE CASE #3

Cost Effectiveness

JUNE 2025

The cost-benefits of wastewater surveillance in urban shelters

Overview

This report looks at cost and benefit elements associated with wastewater-based surveillance (WBS) in urban shelters.

Methods

We reviewed the literature on the cost-effectiveness of WBS programs in shelters and interviewed Dr. Claire Oswald, an associate professor at Toronto Metropolitan University in the department of geography and environmental studies. Dr. Oswald discussed WBS use in 2021 in three shelters in Toronto.

It is important to note that the conclusions in this report are based on limited information in the literature and a single use case of WBS, and therefore may not be generalizable to other WBS programs in shelters.

Resources for Decision-makers

Is your organization considering wastewater-based surveillance? Here's a tool that can help you undertake a cost-benefit analysis of combined WBS + clinical testing:

Cost-Benefit Analysis of Wastewater-Based Surveillance and Clinical Testing in a Shelter (Excel spreadsheet)

xls

Use Cases of WBS in Shelters

People experiencing housing insecurity, particularly those in shelters, are at a higher risk of respiratory viral infections. This increased risk is partly due to poor living conditions, overcrowded spaces that make social distancing difficult, shared hygiene facilities, inadequate ventilation, poverty, and limited staff and resources within the shelters.[1, 2] Studies indicate that people experiencing housing insecurity and residing in shelters are more likely to test positive for the SARS-CoV-2 virus compared to their unsheltered peers.[2] During the COVID-19 pandemic, people experiencing housing insecurity experienced elevated rates of hospitalization, intensive care unit admissions and death due to COVID-19.[1] To combat the higher risk of morbidity and mortality from infectious disease in this population, it is important to identify infections early and limit spread within the shelter. As noted by Ranasinghe et al.,[1] WBS may be particularly relevant to shelters because WBS does not depend on individual health-seeking behavior and is comprehensive across a population, offering a key advantage for populations with limited healthcare access or individuals who may not be comfortable reporting their symptoms.[1]

As part of our interview, we discussed one potential use case for WBS in shelters that we will use to describe the cost and benefit elements of WBS. The use case is monitoring viral activity such as COVID-19, influenza A and B, and respiratory syncytial virus (RSV) to inform infection prevention and control and outbreak management practices. Future applications of WBS in shelters also include tracking and monitoring the presence of additional pathogens, including the hepatitis A virus, enabling proactive management and intervention strategies.[1] The description below represents one way a WBS system for shelters has been implemented in Toronto shelters and the costs and benefits associated with that implementation.

The facility-based WBS program in three shelters in Toronto ran from 2021 to 2024 with the support of Ontario's Wastewater Surveillance Initiative and from the COVID-19 Immunity Task Force. Ontario's WSI was the largest WBS program in Canada, covering several sites, including community-based wastewater treatment plants, long-term care facilities, universities and shelters. It also included WBS programs in collaboration with First Nations communities. The program provided WBS surveillance data to all public health units across the province of Ontario.[3]

The objective of the WBS program in Toronto shelters was to provide real-time data on the prevalence of SAR-CoV-2, influenza A and B, RSV and Monkeypox virus in the three shelters. The WBS program sent regular reports of the WBS results to Toronto Public Health authorities and the facilities management and staff.

Benefits and Costs of WBS in Shelters

To conduct a cost-effectiveness analysis of the WBS shelter program, researchers need to compare the costs and outcomes of having a WBS program to an appropriate alternative. Two potential alternatives to WBS in shelters could be status quo or enhanced clinical surveillance during a pandemic. The status quo is defined as how case identification currently happens in these facilities when there is no information from WBS; for instance, clinical testing outside of shelters. Enhanced clinical surveillance during a pandemic could include symptomatic testing, testing of close contacts or population-based testing in shelters.

The cost-effectiveness of the WBS program is determined by comparing benefits (such as quality of life, deaths averted, hospitalization, healthcare costs saved) with the costs of a WBS program in shelter facilities with and without WBS. By combining benefits and costs for both WBS and status quo we can estimate a cost per health outcomes saved (such as cost per life saved, cost per QALY saved). There are two options to make this comparison: 1) real-world data analysis, where health outcomes and costs are compared between communities with and without WBS after controlling for other factors that can impact these outcomes or 2) a modelling study, where we model the impact of early detection of respiratory viruses on health and healthcare outcomes and costs using available data.

Which benefits and costs are included depends on whose perspective you are using for the analysis. For this overview, we focus on a healthcare perspective, which looks at the health outcomes and costs but not broader impacts (e.g., productivity loss from work time lost). In the following sections, we summarize the potential benefits and costs of the WBS program in shelters.

Benefits

The use of WBS in shelters may offer several potential benefits in comparison to status quo, which should be assessed as part of a cost-effectiveness analysis. According to the literature and our expert interview, WBS acts as an early warning and detection system to identify outbreaks[4] before they spread throughout the shelter, enabling the implementation of preventive measures and offering critical lead time for swift responses to minimize future transmission.[5] Early detection of infection allows staff to promptly initiate cleaning and testing protocols, isolate those with relevant symptoms and screen potential cases — thereby reducing the likelihood the virus will continue to spread among the shelter.[1, 5, 6]

Early detection may be particularly important in shelters that have limited staff resources, which may be quickly overwhelmed in the case of a large outbreak. Moreover, it allows staff to take precautionary measures to prevent themselves from getting sick, including masking and hand hygiene.

During the interview, Dr. Oswald highlighted that hospital-based physicians had described a high rate of emergency room (ER) visits for respiratory infectious diseases from the shelter system. Between 2018 and 2024, the three shelters with WBS had 37 outbreaks, which were associated with 37 hospitalizations and 4 individuals ending up in the intensive care unit. These outbreaks were for a range of diseases, including influenza A, COVID-19, invasive group A streptococcal disease and unspecified gastroenteritis. The statistics are summarized in Table A1 in Appendix A. By using WBS to limit the onward spread of infection, WBS could potentially reduce the number of ER visits and hospitalizations from these shelters. With fewer infections, there may be reductions in other healthcare use, including walk-in doctor visits, hospitalizations and deaths. At the same time, if the results from the WBS program could be shared with local hospitals, it could help prepare them for an influx of cases by adjusting their resources and staffing levels in the ER and hospital.

Costs

In analysing cost-effectiveness, we need to consider the costs of the WBS program in the shelter setting compared to not having a WBS program in place. These include:

- Labour costs (e.g., laboratory manager, field technician, laboratory technician)
- Equipment (e.g., autosampler and its parts)
- Costs of field consumables (e.g., bottles, gloves, protective masks)
- Costs of laboratory consumables (e.g., laboratory tests)
- Shipping and travel costs (e.g., personnel's travel between the site and laboratory, sample shipping to laboratory)
- Costs of data processing, management, communication and reporting

Another cost to consider is the time that shelter staff and public health need to review the WBS results and act upon them. These costs would need to be compared to the costs associated with the status quo (i.e., no WBS system in place), including any additional PCR testing costs and the additional healthcare costs described above.

Limitations and Considerations

The implementation of WBS in the shelter setting presents several key limitations that may influence analysis of cost-effectiveness. The ability of shelters to use the results of the WBS program effectively depends on their capacity to allocate sufficient human resources and staffing to review the results, as well as adequate time to act upon them. Consequently, the potential benefits of WBS may be reduced if some shelters are unable to use the data and results due to staffing shortages.

An additional limitation that could affect the quality of the samples collected and consequently the results generated by the WBS program — particularly in shelters — is the lack of dedicated space for the autosampler in some facilities. Without dedicated space, the autosampler cannot be left unattended and 24-hour sample collection may not be feasible. This could compromise the representativeness of the sample because it would be a shorter snapshot in time. Finally, not all shelters are logistically suitable for initiating a WBS program. Accessing wastewater pipes may be difficult in certain locations, which may result in higher set-up costs.

References

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Appendix A

Table A1: Count of confirmed outbreaks and hospitalizations in shelters of interest, 2018 – 2025

Year	Disease	Number of outbreaks	Number of hospitalizations	Number in ICU*
2018	Influenza A	1	12	N/A
	Invasive Group A Streptococcal Disease (IGAS)	1	0	N/A
2019	No outbreaks	None	None	N/A
2020	COVID-19	8	7	0
2021	COVID-19	7	7	3
2022	COVID-19	9	8	1
2023	COVID-19	5	1	0
	Influenza A	2	2	N/A
	Unknown	1	0	N/A
2024	COVID-19	2	0	N/A
	Gastroenteritis Unspecified	1	0	N/A
2025**	No outbreaks	None	None	None

Data as of March 19, 2025

***ICU data is received for COVID-19 cases only between 2020 - July 1, 2023**
** 2025 has data for a partial year, as the 2025 year is ongoing.

Source: Ontario Ministry of Health and Long-Term Care, integrated Public Health Information System (iPHIS)

Wastewater-Based Surveillance for Public Health:
A Knowledge-to-Action Series. Part 4. Cost-Effectiveness Use Cases.
The Cost-Benefits of Wastewater Surveillance in Urban Shelters.

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