WASTEWATER-BASED SURVEILLANCE FOR PUBLIC HEALTH

KNOWLEDGE TO ACTION SERIES

USE CASE #1

Cost Effectiveness

JUNE 2025

The cost-benefits of wastewater surveillance in long-term care

Overview

This report looks at cost and benefit elements associated with wastewater-based surveillance (WBS) in long-term care (LTC) facilities.

Methods

We reviewed the literature on the cost-effectiveness of WBS in LTC and interviewed Dr. Marc-Denis Rioux, a professor at Université du Québec à Rimouski from the mathematics, computer science and engineering department. Dr. Rioux described a WBS program that was initiated in a Quebec long-term care home in 2020 in collaboration with several universities and provincial and federal government agencies.

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

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:

LTC Cost-Benefit Analysis of Wastewater-Based Surveillance and Clinical Testing (**Excel spreadsheet**)

Use Case of WBS in LTC

LTC residents are at an elevated risk of respiratory infections and severe outcomes from those infections due to age, co-morbidities, dense living conditions and the potential for importation of viruses from visitors and staff.[1] Respiratory diseases such as chronic obstructive pulmonary disease (COPD),[2] pneumonia and influenza are common causes of death among the elderly Canadian population.[3] In 2022, more than half of the deaths from influenza and pneumonia occurred in individuals aged 85 and older in Canada. Moreover, studies have demonstrated that the respiratory syncytial virus (RSV) attack rate (i.e., the proportion of residents exposed to RSV who subsequently test positive) among LTC residents ranges from 12% to 38%.[5] A study by Ursic et al. (2016) on the incidence of acute respiratory infections (ARI) in nursing homes reported that 20% of residents diagnosed with RSV died during an outbreak.[6] These risk factors highlight the critical importance of implementing preventive measures in LTC facilities.[1] During the pandemic, multiple WBS-LTC programs were initiated across Canada.[7, 8]

As part of our interview, we discussed one potential use case for WBS in LTC facilities, that we will use to describe the cost and benefit elements of WBS. The use case is the early detection of respiratory tract infection viruses, including influenza A and B or SARS-CoV-2, to implement control and prevention measures earlier than with traditional clinical testing methods alone. The description below represents one way a WBS-LTC program was implemented in Quebec and the costs and benefits associated with that implementation.

A key objective of the WBS-LTC program in Quebec was to monitor for the respiratory viruses SARS-CoV-2, Influenza A and B, and respiratory syncytial virus (RSV), with the aim of identifying and responding to potential outbreaks within the facility. WBS would act as an early warning system, so staff could implement control and prevention measures as early as possible to stop the spread of infection.

The Quebec WBS-LTC program was run in parallel with clinical testing, which is crucial in diagnosing individual cases, but has several limitations as an early warning system. Clinical testing often only occurs when individuals present with symptoms or when they are in close contact with a case, which can delay case identification. Identification delay is even more likely at the peak of an outbreak or during a pandemic when labs may be overburdened. Clinical testing also has high costs at the population-level; it would take substantial resources and time to regularly conduct population-level clinical testing of LTC residents. Generally, WBS is complemented with clinical testing to provide more accurate information at the individual-level, as the samples collected through WBS may represent the health status of hundreds of individuals residing in a facility.[9] It is important to note that the aim of WBS in LTCs is not to replace clinical testing. WBS provides group-level information; although we lose the identity of the individual carriers, it offers true population-level data. Clinical testing provides important information that allow for individual-level actions, such as decisions regarding quarantine or contact tracing.[10]

Benefits and Costs of WBS in LTC

To conduct a cost-effectiveness analysis of WBS in LTC, researchers need to compare the costs and outcomes of a WBS-LTC program to the status quo (i.e., clinical testing when symptoms arise, testing of close contacts and/or population-based testing during an outbreak). Comparing benefits (such as quality of life, averted deaths, hospitalization and healthcare costs saved) with the costs of a WBS program will determine if the value outweighs its costs. By combining benefits and costs for both WBS and the status quo, we can estimate a cost savings per health outcome (e.g., 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 LTC facilities with and without WBS (after controlling for other factors that can impact these outcomes) or 2) a modelling study of the impact of early detection of respiratory viruses on health and healthcare outcomes and costs using available data.

Which benefits and costs are included depend 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 such as productivity loss from work time lost.

Benefits

Using WBS alongside clinical surveillance may have several potential benefits that would need to be measured as part of a cost-effectiveness analysis. Based on the Quebec use case of WBS in LTC, the key benefit is detecting an outbreak earlier than typically identified through clinical testing.[7] WBS can identify a potential respiratory virus signal before patients are symptomatic, which provides valuable response time. Studies have already demonstrated the possibility for early detection, with a study by Piggott et al. (2023) showing that the WBS signal for an outbreak could be detected 2-10 days before the confirmation of an outbreak through clinical testing.[11]

The main potential health benefit of early detection is the reduction in the number of respiratory infections, as well as secondary bacterial infections and deaths in LTCs. There may also be improvements in healthcare outcomes, including reductions in medications, testing, LTC personnel time (e.g., nurses), hospitalizations and associated healthcare costs. Moreover, by reducing negative outcomes, WBS may also lead to improvements in resident quality of life.

Costs

We also need to consider the additional cost of a WBS program, including: staff costs (e.g., sampling staff, lab technician), costs of sampling (e.g., equipment, reagents, bottles), costs of lab equipment (e.g., mixer, centrifuge), analysis costs (e.g. protein quantification system and quantitative real-time polymerase chain reaction), and data management and reporting costs. 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 as described above. Moreover, it would be important to capture the potential risks associated with using WBS as an early warning system in LTC, including the health benefits and costs associated with additional testing (e.g., if testing is used to confirm who is infected after a signal in the WBS), and unnecessary implementation of control measures (e.g., detection of virus that would not have led to an outbreak).

Limitations and Considerations

There are some key limitations to the implementation of WBS in LTC that would need to be considered in a cost-effectiveness analysis. There are several limitations that may limit benefits and increase costs. First, it is currently difficult to monitor specific zones in LTC facilities as access to the wastewater is generally at the facility level, and accessing pipes in other parts of the system is not possible with the tools currently available. By having a more specific WBS monitoring system, it would be easier to identify the location of the outbreak and contain it. Work is currently underway to develop tools that can more easily access wastewater at different points throughout a facility. Second, not having sustainable funding can lead to loss of expertise and the need to retrain employees, which increases costs. Third, some residents in LTC may be in diapers and would not contribute to the WBS system, limiting the data available.

Aside from the limitations identified above, determining cost-effectiveness could be challenging. While there is evidence that WBS can signal the start of an outbreak, how to use WBS in practice in these facilities has not been defined, and therefore policies and procedures around WBS would need to be developed before testing its benefits on health care outcomes. This also means there is limited data on the effectiveness of WBS in preventing cases, hospitalizations and deaths. Establishing cost-effectiveness is difficult when a lot of unknowns remain.[10]

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

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