

Health Analytics Innovation During the COVID-19 Pandemic

To: Chair and Members of the Board of Health

Meeting Date: May 11, 2022

Report No. **BH.01.MAY1122.R12** Pages: 15

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Recommendations

It is recommended that the Board of Health:

1. Receive this report for information.

Key Points

- WDGPH has applied numerous innovative analytical approaches through the COVID-19 pandemic
- Analyses provided to decision makers and to the public have been of highest accuracy and timeliness
- Impact of these analytic approaches has included:
 - enhanced risk communication to public
 - mitigating pandemic disruption to families with children in school
 - vaccine prioritization for higher risk populations

- efficient and equitable clinic planning

Discussion

Introduction

Health Analytics has used a number of innovative analytic approaches and methodologies during the pandemic, which facilitated the agency's use of data and ultimately led to quicker and improved decision-making. An innovative approach is defined as one situated on a spectrum, ranging from something new to the agency to something no organization has ever attempted before. Many of the examples described in this report fall closer to the *new to the agency* side of the spectrum, although many are techniques that few PHUs in Ontario used. This report summarizes a few of the more impactful approaches used by Health Analytics.

Public Dashboards

Over the past two years, WDGPH has used public dashboards to regularly provide information to the public about the local COVID-19 situation. As the situation has evolved, we have aimed to highlight what are the most important indicators of COVID-19 activity in the community, and its impact on our health system capacity. To respond rapidly in this respect, we adopted an Agile project management approach to our public dashboard development. With this, new features were taken quickly from initial designs to being publicly visible, and those designs iteratively enhanced. Our public dashboards have continually showcased innovation within Health Analytics at WDGPH, including being:

- One of the first PHUs to provide estimates of the local effective reproductive number, which was made public Summer 2020.
- First PHU to publish case rates by vaccination status (August 23, 2021). This was later provided by the province on September 8, 2021.
- First PHU to publicly report vaccine dose numbers, starting only 3 business days after the first vaccine was administered in WDG.
- First PHU to provide vaccination coverage by school (see *School specific COVID vaccine coverage estimates*). This was first made public July 22, 2021 for secondary schools only, with elementary schools added October 26, 2021.
- Published wastewater surveillance-based COVID-19 indicators, alongside select comparators on Feb 17, 2022 (see *Wastewater analyses*)

- Have quickly reflected vaccine eligibility changes in key indicators throughout vaccination campaign, resulting in 18 major releases in 2021.

School specific COVID vaccine coverage estimates

Soon after children and youth became eligible to be vaccinated, WDGPH developed an approach to monitor student vaccination rates within our schools.

When a client attends a vaccine clinic, numerous client details are collected and verified. While in many cases, school name is included in the information collected from clients who are students, this field was found to be insufficient for accurate school specific reporting. Limitations include a) school year inconsistency during summer 2021 vaccination campaign; b) institution or reason for immunization being superseded by another value such as health care worker/facility, health condition, or indigeneity; and c) selection errors for schools with common names.

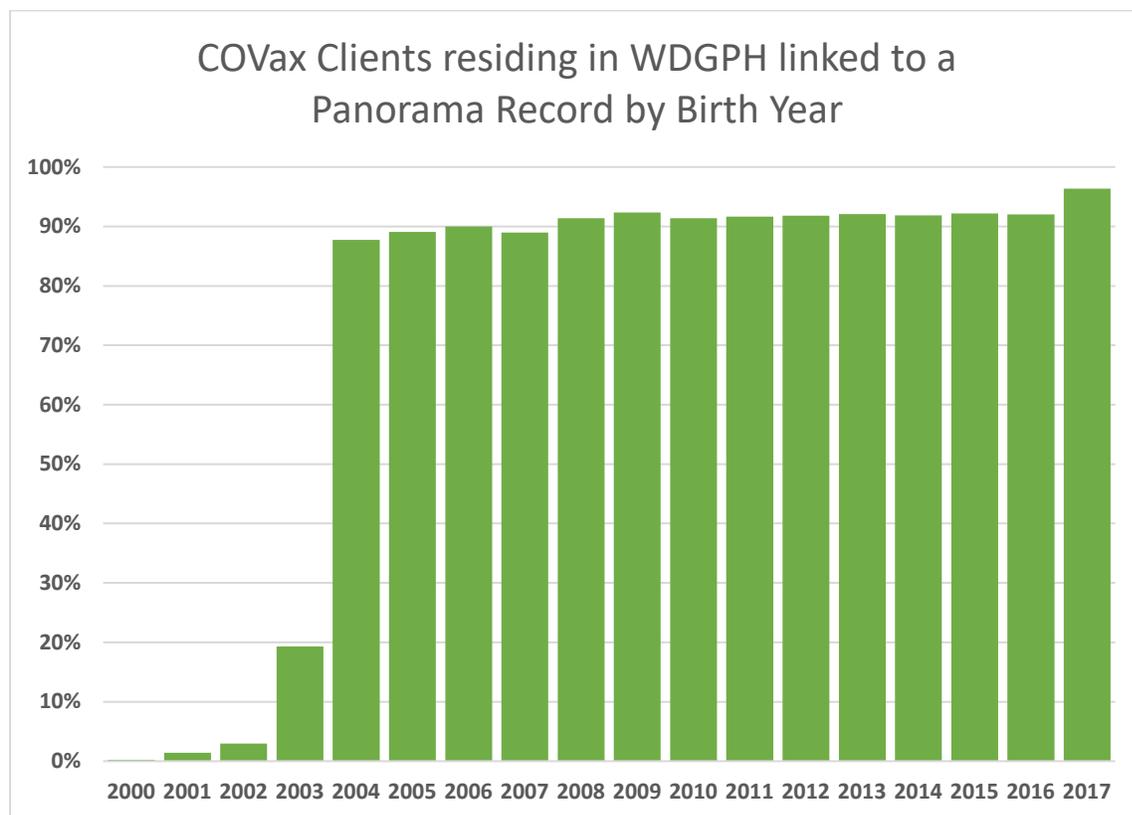


Figure 1: Percentage of Clients in COVax (the information system used in Ontario for vaccination against COVID) that are indicated as residing within WDGPH, that have been linked to a record in Panorama (the information system used for vaccination records under ISPA) are shown by birth year. Data updated March 15, 2022.

Rather than relying on a school name provided at time of vaccination, WDGPH leveraged an existing information system for tracking of other student vaccinations. As part of obligations under the Immunization of School Pupils Act (ISPA), Ontario PHUs receive complete student lists from school boards and independent schools within their region, which are inputted to a provincial information system called *Panorama*. There are number of fields common across *COVax*, the information system used for COVID vaccination data, and *Panorama*, which when used together, can be used to create a robust linkage across the databases. We developed a probabilistic linkage model that accounts for common data errors such as transpositions in birth date, or health card number. Ambiguous linkages are flagged for staff review before use in our reporting. The linkage rate of a client that is considered in *COVax* to reside within WDGPH, to a record in *Panorama*, is approximately 90% for the most common birth years in our school system (*Figure 1*).

For the 2021-2022 School Year, WDGPH requested and received updates to student information from school boards and independent schools in the region at an increased frequency in comparison to previous school years to enhance the accuracy of our school-based vaccination reporting.

Risk Analysis and Communication

Like with other vaccine preventable diseases, COVID vaccination rates are important indicators and predictors of community health. During the COVID-19 pandemic, vaccination rates within schools specifically, have been a key risk factor that has guided our activities as a PHU, such as the planning of targeted community and school clinics, and identification of high-risk schools for inclusion in Ontario's Fall 2021 School Rapid Antigen Test distribution program.¹ WDGPH continues to be one of few Public Health Units in Ontario to publish and maintain school vaccination rates. In doing this, families have had more risk information for their decision making during the school year. School based public reporting has led to more conversations around vaccination within school communities, which ultimately, we believe, has led to increased vaccine comfort and uptake.

Support of Optimized Student Self Isolation Requirements

Additional benefits were realized because of our vaccination record linkage process for local students. During fall 2021, WDGPH introduced self isolation requirements for students in classrooms with a confirmed case of COVID-19 based on student vaccination status.² Confirmation of new cases of COVID-19 often occurs during the regular school day. Prior to our changes to self isolation requirements, all students were dismissed at time of case confirmation in their classroom, often necessitating special transportation arrangements by student families. Beyond transportation, families had to arrange for PCR testing, and often altered work arrangements to provide supervision of

dependents. WDGPH's updated self isolation requirements enabled students that had received two doses of vaccine at least two weeks prior to their possible exposure, to continue with their in-person learning. To operationalize these self isolation requirements, WDGPH had to rapidly confirm vaccination status of students in classrooms with a positive case. This was only feasible because of the internal tools built around our accurate vaccine data linkages. We estimate that there were thousands of instances of students who were able to remain in school because of this process.

Vaccination Spatial Analyses

WDGPH has performed extensive spatial analyses during the COVID-19 pandemic, especially during the vaccine rollout. While key metrics have evolved, there has been a consistent need for high accuracy and detail in this work. Our mapping efforts have enhanced our surveillance of COVID-19 activity and have been essential in efficiently and equitably deploying resources through our vaccination campaign with clinic planning, partner engagement, and public messaging.

Limitations of External Spatial Analyses

The Ministry of Health has regularly provided or made available spatial analysis products to PHUs, typically at one of three levels of aggregation:

- PHU-level
- Forward Sortation Area (FSA)
- Dissemination Area (DA), using postal code

PHU-level

PHU-level analyses have allowed for identification of PHUs whose strategies have been particularly effective for reaching specific population segments; with those learnings shared through multiple channels.

Forward Sortation Area (FSA)

For PHUs with dense urban populations, FSA-based analyses have allowed vaccination insights that are more detailed than those at the PHU-level. Due to the typical FSA population size, many FSA-based analyses have been determined to be suitable for publication. FSA-based reporting typically does not require any additional data collection or significant new processes. Due to the population density through the WDG region, our FSAs are typically too geographically large to provide guidance for targeted activities. Many of our rural FSAs span multiple PHUs (e.g., NOB falls within WDGPH, as well as 6 other PHUs), and are discontinuous areas or have irregular boundaries.

Dissemination Area (DA)

A limited number of spatial analyses have been made available at the DA level to PHUs. This geographic unit typically has populations less than one thousand, which is small enough for targeted outreach. Additionally, each DA is completely contained within a single municipality, county, and PHU. For each externally produced DA-level analysis, mapping has been completed using postal code only. Like issues around use of FSAs as geographic units in low density areas, single postal codes in rural areas often span multiple DAs. The result is some DAs will have very few (or no) linked clients, and other DAs with more linked clients than are known to live there. In these analyses, low or high vaccination rates in rural DAs are typically artefacts of assuming an entire postal code maps to single dissemination area. Linking a single postal code to a single statistical area can be very useful, but when involving low density, and even medium density areas, high degree of caution is required at the DA-level. In medium density areas, like within the City of Guelph this can be done with reasonable reliability to the next largest statistical geography, the aggregate dissemination area. In low density areas, like rural areas in Wellington County, this is best done to even larger statistical geographies, like municipality, or county. In all cases, there will be limited fidelity with an exclusively postal code-based methodology.

WDGPH Methodology

For COVID case and vaccination data, when address detail is sufficient, WDG will accurately determine the client DA through a process called geocoding. In instances where an address is insufficient to assign a client with certainty to a single DA, that uncertainty is represented by dividing a single COVID-19 case or vaccine dose into multiple DAs, weighted based on the probability of each DA being the true area of residence based on postal code. When we perform geographic aggregation for calculation of vaccination coverage, we have the highest accuracy possible using address detail with varying levels of quality. While DA level analyses have not been appropriate for public reporting, DAs are further aggregated to geographies that are privacy preserving and most relevant for our public COVID-19 dashboards (see *Figure 2*).

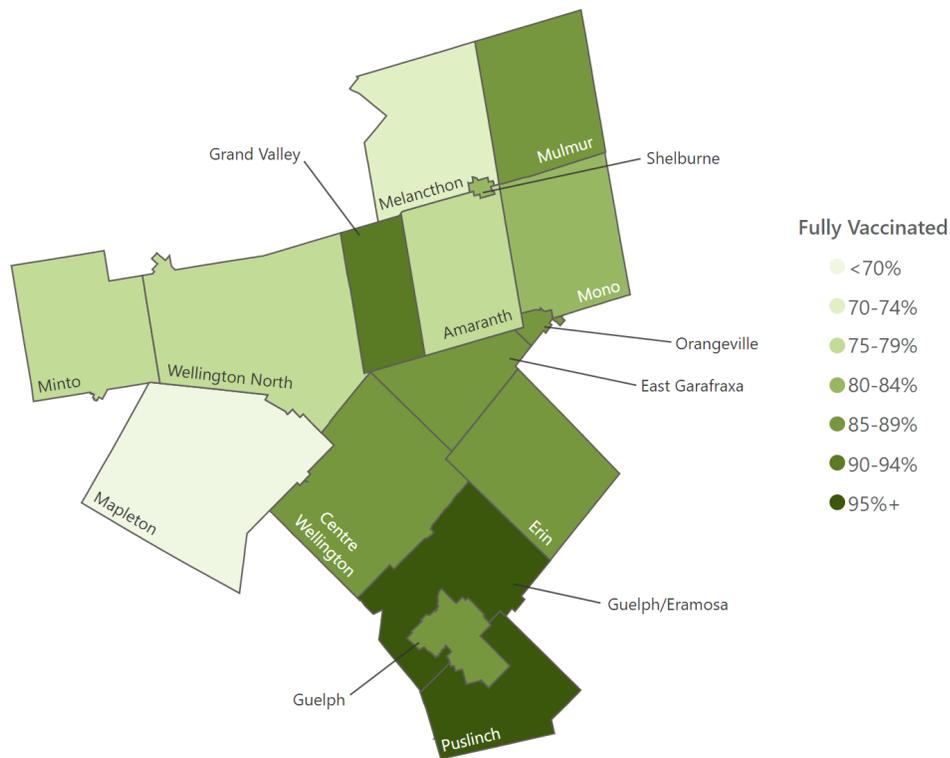


Figure 2: WDGPH reporting of vaccination coverage by municipality is shared on our public dashboard. This reporting uses geocoding to ensure high accuracy.

WDGPH Spatial Analyses in Support of Vaccine Prioritization

It became clear early in the pandemic that different segments of the population were at varying levels of risks for exposure and to severe outcomes from COVID. In conjunction with spatially aggregated case and vaccination data, we used marginalization indicators³ to identify areas of residence, education, and occupation to prioritize with booking and clinic planning. This was done to complement a provincial ‘hot spot’ analysis that operated at the level of FSA only. The provincial analysis indicated all of N1K for prioritization, which encompasses at least 15 DAs (see Figure 3). N1K is one of the smallest FSAs completely contained within WDGPH, but still, it provided only a coarse targeting/prioritization opportunity due to its large geographic and population size. DA-level analyses allowed us to be much more precise in the prioritization of our highest risk population for vaccination. This resulted in more of the population at the highest risk, vaccinated earlier – enabled also by having our own pre-registration system. As availability of vaccine increased, the impact of WDGPH’s spatial analyses

shifted more towards outreach efforts such as having repeated vaccination opportunities at specific workplaces, multi-residential buildings, and community hubs.

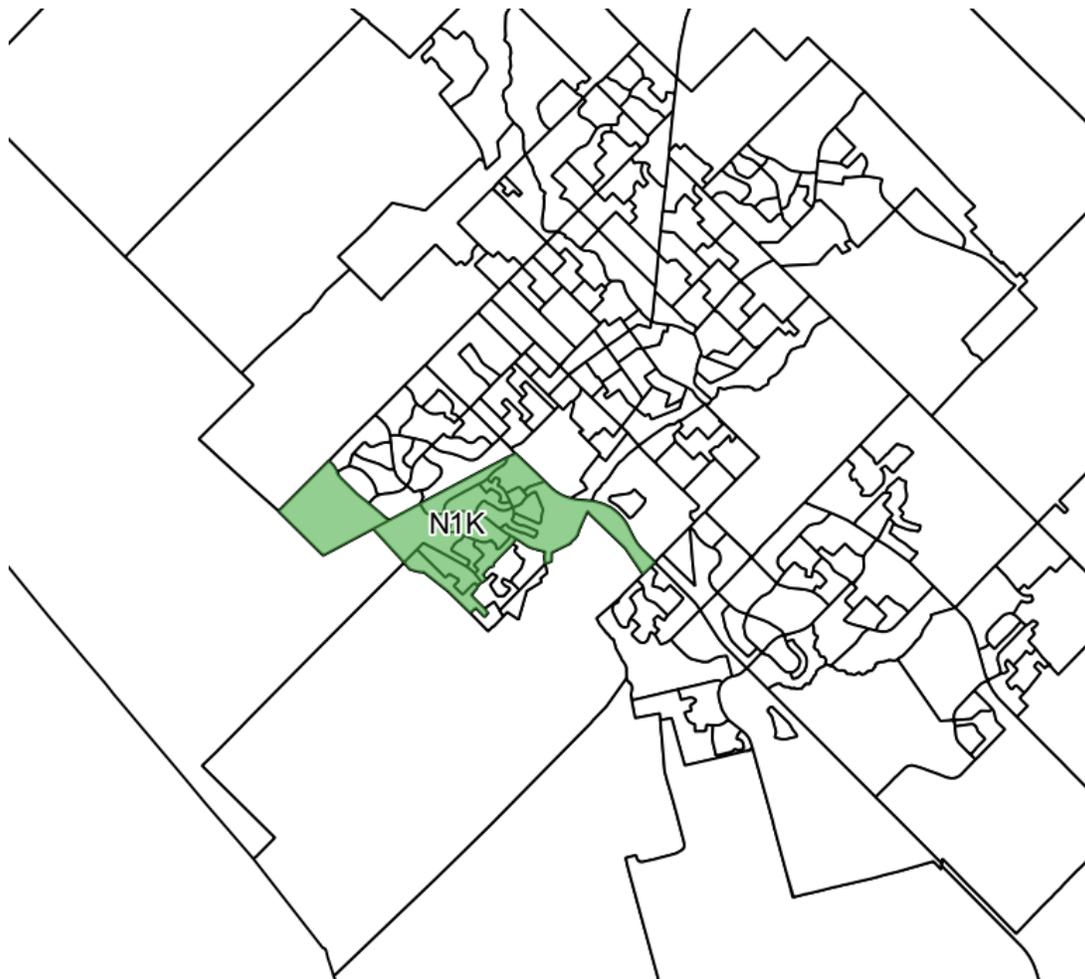
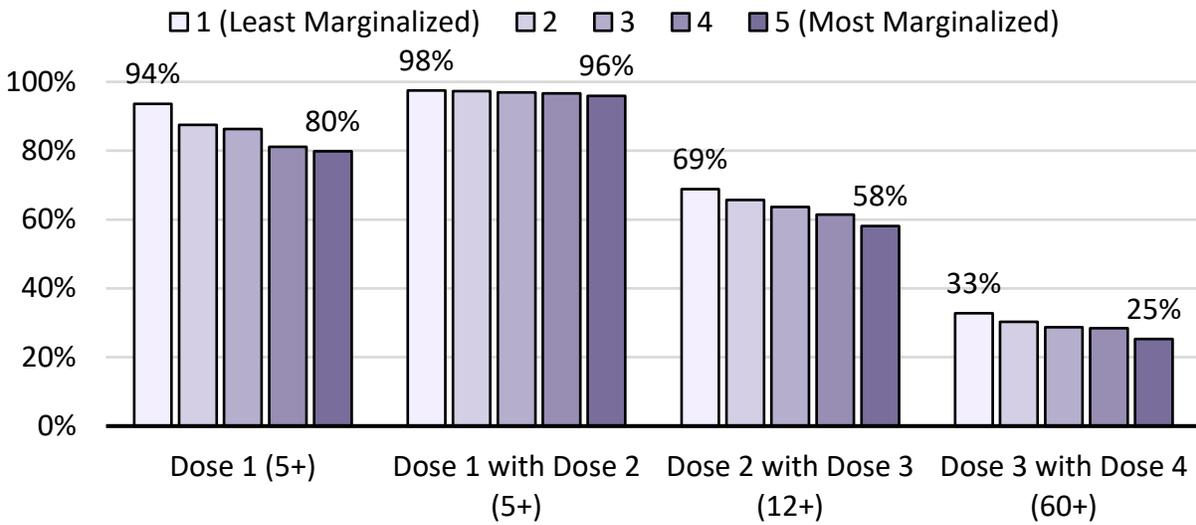


Figure 3: N1K was identified as a provincial hotspot by the Ministry of Health. N1K encompasses at least 15 distinct Dissemination Areas (DAs) within the City of Guelph. WDGPH DA-level analyses determined that the population at highest risk within the region included DAs not exclusively contained by N1K.

WDG has continued to monitor vaccine uptake across marginalization indicators to inform clinic planning, targeted messaging, and community partnerships. The material deprivation index shows some of strongest relationships with our vaccination metrics. In Figure 4, we see a consistent association between higher marginalization, and lower progress on each of the vaccination progress indicators shown.

Material Deprivation and COVID Vaccination Progress



Material Deprivation Index in Wellington-Dufferin-Guelph

ON-MARG 2016

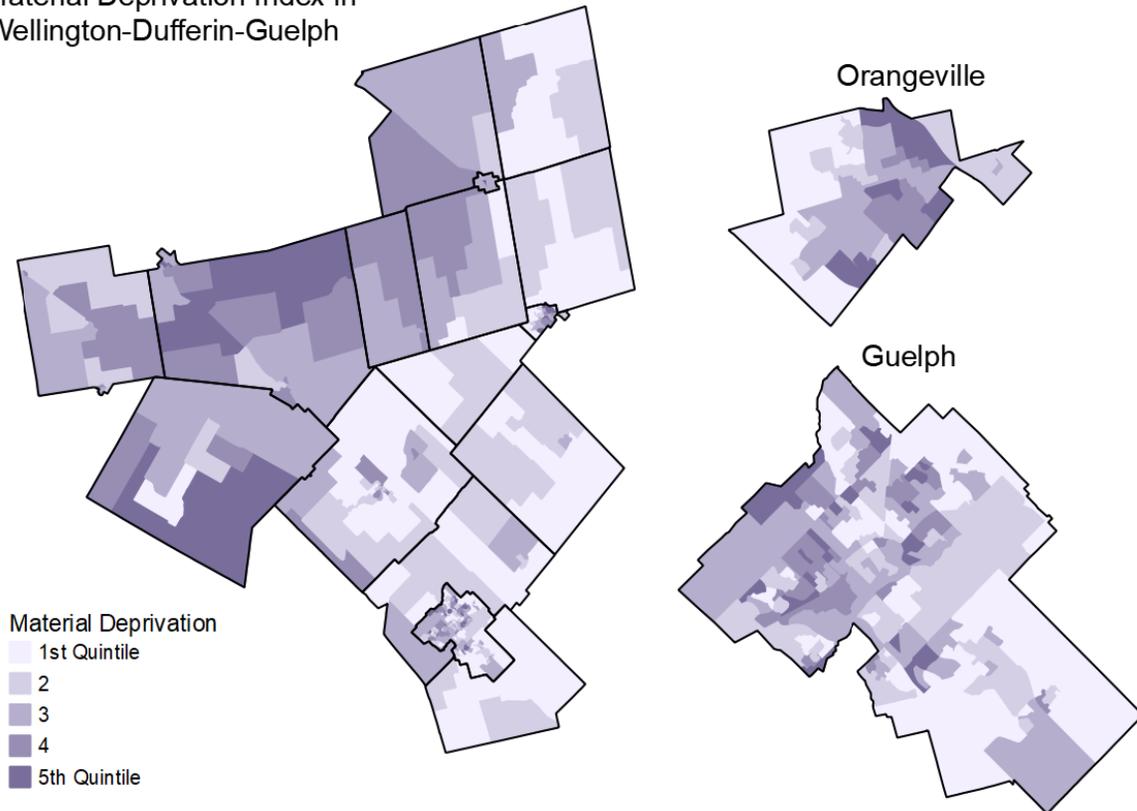


Figure 4: WDGPH monitors vaccination metrics across marginalization indexes (ON-MARG 2016). Data are up to date as of May 4, 2022.

Wastewater analyses

Starting between late 2020 and early 2021, in Guelph and Orangeville respectively, samples of wastewater have been collected for COVID-19 surveillance purposes. These samples have been analyzed in labs at the University of Guelph to determine concentrations of genetic markers of SARS-CoV-2, which serves as an indicator of COVID-19 activity in the sewershed. These data, in turn have supplemented clinical data on cases in the community. There are several advantages to these data:

- They do not include personal health information and do not have same privacy considerations as clinical data
- They are not modulated by health seeking behaviour
- They are not impacted by test accessibility or eligibility

There are also limitations:

- Signal is inherently noisy
- Relationship with respect to cases may vary by variant, or client characteristics like vaccination status or age
- Can not identify specific groups at higher risk to deploy interventions
- Relies upon centralized wastewater treatment, which is only available for specific communities within WDG (the Wastewater Surveillance Initiative covers 75% of population of Ontario, and 56% of the WDG population)
- Sample collection, transportation and processing is intensive and results in data lag of several days

Public communication

With difficulty in fully communicating the limitations of these data, and extensive clinical testing available, WDGPH reserved wastewater data for internal monitoring in 2021. As availability of clinical testing was greatly reduced at the start of 2022, this decision was re-evaluated, and wastewater data was added to our COVID cases public dashboard on February 17, 2022. The concentration of the SARS-CoV-2 N1 gene in wastewater, in genetic copies per ml, is provided alongside several comparators including case rates, hospitalization data, and test positivity (Figure 5).

Use the tabs below to explore the information available within this report.

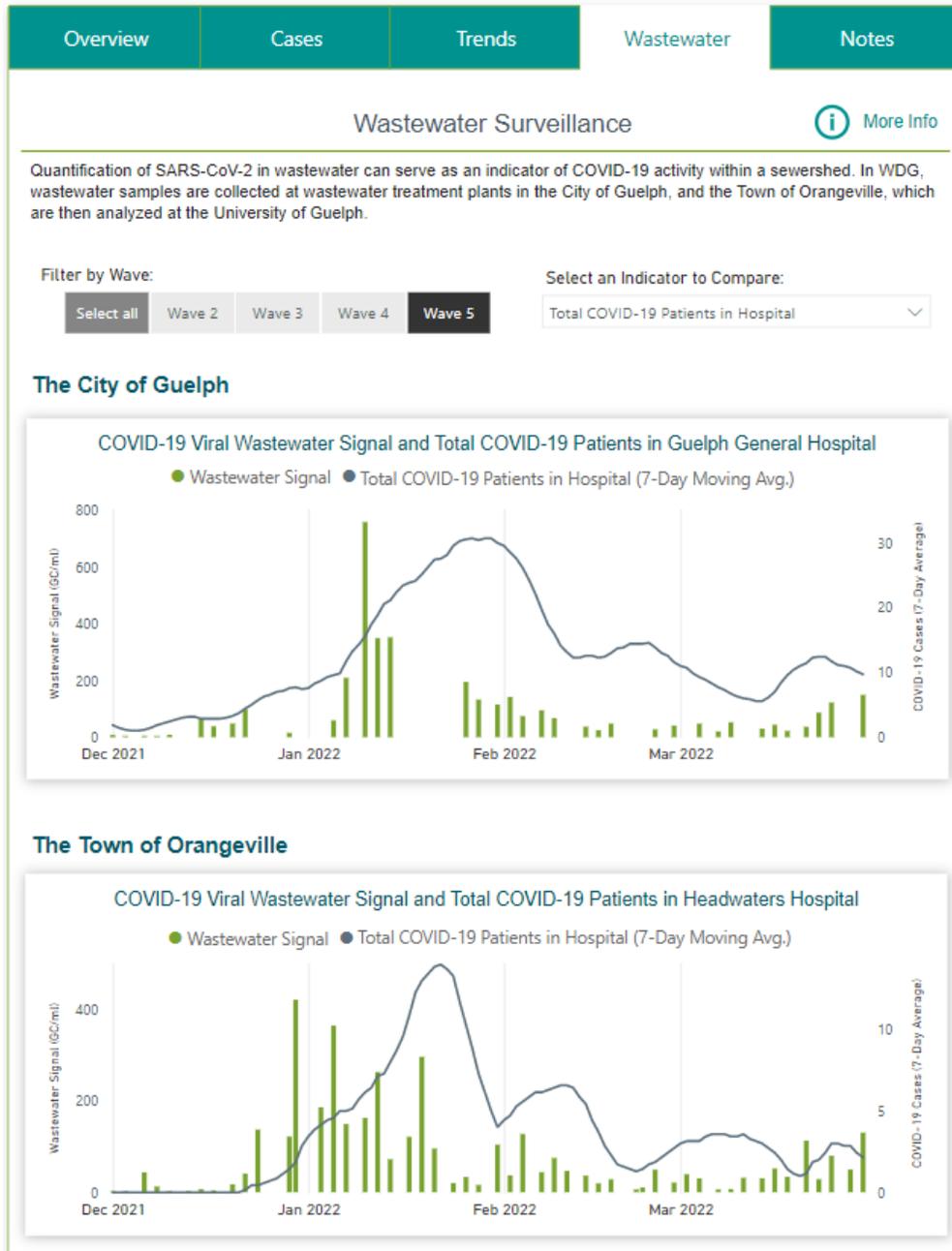


Figure 5: Wastewater data was added the WDGPH COVID-19 Cases dashboard Feb 17, 2022, and includes comparators with other key indicators of COVID-19 activity in the community. Data shown from April 7, 2022

Conclusion

The pandemic has demonstrated analytical capacity at the PHU level is a key component of pandemic and emergency readiness. Analytics at WDGPH has regularly provided decision support through the COVID-19 pandemic and has ensured that planning has been evidence based and data driven. This report has provided just a few examples of analytics innovation at WDGPH, which have had direct contributions to operational efficiency, public engagement, pandemic impact mitigation, and equitable service delivery.

Ontario Public Health Standard

Population Health Assessment

“The board of health shall use population health, social determinants of health, health inequities, and other sources of information to assess the needs of the local population, including the identification of populations at risk of negative health outcomes, in order to determine those groups that would benefit most from public health programs and services (i.e., priority populations).”

Health Equity

“The board of health shall modify and orient public health interventions to decrease health inequities...”

“The board of health shall lead, support, and participate with other stakeholders in health equity analysis...”

Immunization

“The board of health shall conduct epidemiological analysis of surveillance data for vaccine preventable diseases, vaccine coverage... including monitoring of trends over time, emerging trends, and priority populations...”

Infectious and Communicable Diseases Prevention and Control

“The board of health shall conduct population health assessment and surveillance regarding infectious and communicable diseases and their determinants. These efforts shall include... [c]conducting surveillance and epidemiological analysis, including the monitoring of trends over time, emerging trends, and priority populations...”

“The board of health shall, based on local epidemiology, supplement provincial efforts in managing risk communications to appropriate stakeholders on identified risks associated with infectious diseases and emerging diseases of public health significance.”

School Health

“The board of health shall work with school boards and schools to identify opportunities to improve public knowledge and confidence in immunization for school-aged children by... [d]eveloping and implementing regional/local communications strategies, where local assessment has identified a need;”

2020 WDGPH Strategic Direction(s)

Service Delivery: We will provide our programs and services in a flexible, modern and accessible manner, and will ensure they reflect the immediate needs of our Clients and our role in the broader sector.

System Transformation: We will equip the Agency for change in all aspects of our work so that we are ready for transformational system change when the time comes.

Knowledge Transfer: We will ensure that our decision-making and policy development efforts are informed by meaningful health data at all times.

Health Equity

WDGPH analyses during the COVID-19 pandemic have been conducted with the goal of identifying population segments, areas, and factors of marginalization that may lead to disproportionate impact from COVID-19. These impacts include those to health, such as hospitalization or death. They may also be financial or social disruption such as inability to work due to having COVID-19, caring for a dependent whom has been infected, or other isolation-related impact.

In the first year of the pandemic, our available population-based interventions were primarily policy-based (e.g., introducing masking requirements in common areas of multi-unit residential buildings⁴) and communication of risk-based. As vaccine arrived in the region, our available interventions became much more directly effective towards reducing transmission within communities, and severe health outcomes for individuals.

It was identified early in the pandemic that vaccination supply and efforts must be distributed equitably. WDGPH, and the province, approached this from several directions. In [WDGPH Spatial Analyses in Support of Vaccine Prioritization](#), we discuss how, as a result of our spatial analyses, WDGPH was able to prioritize marginalized communities, areas which have had high impacts due to COVID-19, and areas of lower vaccination coverage, to receive vaccine earlier. Additional approaches included age-stratification of vaccine availability due to heightened risk of severe outcomes from COVID-19 infection, as well as prioritization of higher risk and essential occupations.

[School specific COVID vaccine coverage estimates](#) have been important identifiers of communities which may require more opportunities for vaccination, increased accessibility, or specific communication strategies. Not only have these been informative to vaccine clinic planning, but they were also used in our selection of pilot schools in Fall 2021 for rapid testing initiative.

Understanding that transparency is central in building and maintaining public trust, we have placed high importance on communication of our COVID-19 case and vaccination data. We assembled a multi-disciplinary planning and development group to guide the presentation of these data through our popular COVID-19 [Public Dashboards](#). These dashboards have had the intention of effectively communicating risk, gaining trust, and encouraging vaccine acceptance within communities in WDGPH, especially those at highest risk.

References

1. Wellington-Dufferin-Guelph Public Health. Media Release: WDG Public Health will participate in provincial school rapid antigen testing program. [Online].; 2021 [cited 2022 March. Available from: HYPERLINK "<https://wdgpublichealth.ca/news/media-release-wdg-public-health-will-participate-provincial-school-rapid-antigen-testing>".
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4. Wellington-Dufferin-Guelph Public Health. Media Release: WDG Public Health updates masking requirements to protect against COVID-19 variants of concern. [Online].; 2021 [cited 2022 April. Available from: HYPERLINK "<https://wdgpublichealth.ca/news/media-release-wdg-public-health-updates-masking-requirements-protect-against-covid-19-variants>".