OPHESAC Ontario Public Health Emergencies Science Advisory Committee
CCSOUSP Le Comité consultatif scientifique ontarien des urgences de santé publique

Scientific Report: Strengthening Ontario's Respiratory Viral Surveillance System

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Executive Summary

The World Health Organization (WHO) declared an end to the Coronavirus Disease 2019 (COVID-19) public health emergency.[1] However, the serious and potentially avoidable major health and social impacts of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), influenza and respiratory syncytial virus (RSV) together make the case for ongoing investments in surveillance programs for established respiratory viruses. The fall 2022 respiratory viral surge was not an isolated event. Respiratory seasons in Canada and worldwide have important variations in their timing of onset and in their intensity.[2-4] Surveillance programs provide an early warning and alert system designed to help us better prepare and better respond to imminent threats. The purpose of this report is to make evidence-informed recommendations to strengthen Ontario's ability to prepare for, detect, monitor, and respond to established respiratory viral pathogens with epidemic and pandemic potential. These recommendations are designed for rapid adoption and implementation as they build upon existing elements of the provincial surveillance system. Our recommendations provide a specific focus to many of the directions stated in the 2022 Chief Medical Officer of Health's yearly report, towards ensuring efficient, collaborative and equity-driven surveillance that improves prevention and mitigation of respiratory viral public health threats.[5]

Intended Audiences

The Government of Ontario is the principal target of all recommendations. Respiratory virus surveillance systems require improved coordination, better systems to support information sharing, a significant focus on equity especially in their testing strategies, major ongoing investments and continuous improvements. As such, implementation of the individual recommendations will require a coordinated effort of multiple entities by the Government of Ontario, including: the new branch of Treasury Board focused on Emergency Management, the Office of the Chief Medical Officer of Health, Public Health Ontario, local public health units, Ontario Health and the Ministry of Health. Many recommendations will also require concerted efforts from federal ministries to coordinate provincial and local surveillance activities, as public health requires all levels of government to work together.

Summary of Recommendations

We urge the Government of Ontario to consider the following recommendations to strengthen Ontario's respiratory virus surveillance system in providing early warning, alert and response capability to prevent the emergence of, or mitigate the impact of, a future respiratory epidemic or pandemic. These nine recommendations focus on important domains of surveillance including its structure, equity, data governance, efficiency and visibility of health data. Recommendations 1 and 2 address the need for further investment in surveillance mechanisms that improve efficiency in enabling early detection and

onset of annual surges in respiratory viral illness and emerging variants from human or zoonotic reservoirs. Recommendations 3 and 4 focus on making Ontario's surveillance system more equitable, with a specific focus on engaging and empowering Indigenous communities in active surveillance efforts. Recommendations 5 through 8 centre on improving the timely collection of data, its quality and credibility, its coordination and integration across multiple sources and organizations, and the diversity of its sources to overcome inequities related to bias in current indications for laboratory testing. Finally, recommendation 9 highlights data as a public good, justifying its need to be shared with the public.

To summarize, the focus of the recommendations are as follows:

1. Maintain and further invest in an early warning, alert, and response system (EWARS) to prepare for and mitigate the impact of annual respiratory epidemics involving established respiratory viruses: SARS-CoV-2, influenza, and RSV.

2. Ensure coordination of surveillance that promotes a One Health approach integrated at animal-human-environmental interfaces to support the detection of novel variants of respiratory viruses and the emergence of new zoonotic threats.

3. Reduce inequities in public health surveillance, including inequities in access to testing, data collection, and information sharing.

4. Strengthen First Nations communities' ability to obtain and use relevant public health data to inform local respiratory viral surveillance strategies, local public health and hospital preparedness, and timely response to outbreak investigations in partnership with provincial and federal health authorities.

5. Adopt principles of data governance, as outlined by the Canadian Health Data Charter and Ontario Health Data Council Report, to integrate and standardize data collection across health and laboratory systems.

6. Streamline data sharing processes and policies to enhance the usefulness of and access to surveillance and relevant health and socio-demographic data.

7. Reduce fragmentation and redundancies to harness the value of existing laboratory, public health and clinical syndromic information systems (indicators that can be monitored prior to laboratory confirmation, such as influenza-like illness and emergency department visits), to improve timely reporting of trends both locally and provincially.

8. Continue wastewater-based surveillance for SARS-CoV-2, and evaluate its role for influenza and RSV, for early virus detection and identification of variants of concern, to reduce existing inequities in clinical surveillance.

9. Enhance public reporting by promoting timely access to meaningful and comprehensive health information by the public, decision makers, researchers, and the health workforce.

Table of Contents

Purpose

In this scientific report, we make recommendations designed for rapid adoption and implementation as they build upon existing elements of the provincial respiratory virus surveillance system. Our recommendations are supported by discussions with experts from national and international jurisdictions, an environmental scan of national and international surveillance systems and a rapid review of traditional and novel approaches for the detection of common respiratory viruses including SARS-CoV-2, the virus that causes COVID-19, influenza, and RSV.[6,7]

This report is part of a multiphase theme of work aiming to provide evidence-informed recommendations to strengthen Ontario's ability to prepare for, assess, monitor, and respond to established respiratory viral pathogens with epidemic and pandemic potential. The specific focus of work was prioritized by all members of the Ontario Public Health Emergencies Science Advisory Committee (OPHESAC) and aligns with the priorities of the Office of the Chief Medical Officer of Health of Ontario as outlined in its 2022 annual report.[5] The recommendations from this report were informed by the insights of a broad interdisciplinary group of stakeholders with experience and expertise in data systems, ethics, health policy, Indigenous health and First Nations health governance, primary care, infectious diseases, epidemiology, laboratory science and public health.

Background

Each year, Ontario experiences a relatively predictable increase in the prevalence of established respiratory viral illnesses including influenza and RSV among adults, children, and youth. The addition of endemic SARS-CoV-2 infections may result in further changes to the seasonal patterns in incidence and transmission of these respiratory viruses. These three viral illnesses all carry substantial adverse health and social impacts for individuals living, working and attending school in Ontario.[8-11] Respiratory viruses frequently impart enormous strain on the overall capacity of the healthcare system.

In the fall/winter of 2022, Ontarians experienced an earlier-than-expected and more intense spread of RSV and influenza A,[12,13] in addition to the prevailing circulation of SARS-CoV-2, which contributed to substantial work and school absenteeism, healthcare staffing shortages and unprecedented additional strain on health system capacity. In the case of pediatric acute care, the onset of RSV and influenza A occurred two months ahead of their typical season at higher-than-expected levels of transmission, resulting in a tripling of emergency room visits for children and youth over the seasonal average, closure of perioperative services and various provincial directives to meet staffing and inpatient bed demands.[14] It is expected that this year-to-year variation in the timing, transmission, and related impacts of these viral pathogens will continue. Variations in pathogens, their virulence in different populations and clinical consequences all reinforce the need for a high-quality surveillance system that enables Ontario to prepare for, assess, monitor, and respond to established respiratory viral illnesses with epidemic and pandemic potential.

Optimal disease surveillance and monitoring systems are built upon the premise that it is possible to mitigate the adverse health and social consequences of the illnesses caused by various pathogens. The WHO recently published their 'Crafting the Mosaic' framework for resilient surveillance for respiratory viruses of epidemic and pandemic potential.[15] This framework outlines that, to be effective, respiratory surveillance systems must employ a sustainable approach to collect and publicly report data that is timely, integrated, and coordinated to monitor the spread and intensity of respiratory viruses and their related illnesses. These activities are essential to guide public health control measures to mitigate the impact of these viruses. Therefore, a single surveillance system is insufficient to address the complex

needs of a provincial-level respiratory surveillance program. Instead, multiple integrated and coordinated fit-for-purpose systems are required that are complementary and supportive of the overall objective to assess, monitor, and respond to established respiratory viral illnesses with epidemic and pandemic potential.

Ontario has established surveillance systems for detecting and monitoring various adverse health and social effects of SARS-CoV-2, influenza and RSV. These systems include daily measures of disease incidence in the population through laboratory testing for detection of pathogens and variants of concern, disease burden through hospital census, pathogen-related hospitalizations and deaths (monitored for all three pathogens), wastewater surveillance of SARS-CoV-2 for, real-time identification of outbreaks from emergency department activity and outbreaks in congregate care settings (e.g., long-term care facilities).[12,13,16,17] Reporting of the molecular test confirmed cases should flow from the Ontario Laboratory Information System into the Public Health databases; however, this infrastructure is currently not in place. Active surveillance of respiratory viral pathogens via laboratory-based testing takes place year-round, with enhanced testing and reporting processes during surge periods.

However, many laboratories across the province may lack sufficient resources to meet increased capacity needs during times of community surges in incident infections when the system ramps up testing. Ontario also does not have defined thresholds for when to scale back on surveillance activities during periods of low community incidence. Further, clinical indications and eligibility for publicly-funded tests vary among regions, introducing additional variation and potential risk for inequities in access to and uptake of tests and healthcare resources within the system. Ontario's respiratory viral surveillance system also lacks capability for other surveillance activities such as methods to achieve earlier detection and measures of community incidence/prevalence through use of universally integrated and available clinical syndromic data, reporting of school and childcare absenteeism, and other specific measures for specific pathogens like RSV such as reporting of cases, deaths, and institutional outbreaks. There is also great potential for fragmentation and gaps in data availability across multiple sources. This fragmentation may result from limited coordination and integration of these data that can lead to delays in data sharing and timely reporting (including transparent public reporting) to inform public health response measures.

From an equity perspective, Ontario currently collects limited sociodemographic data for laboratory-confirmed and clinical syndromic cases of SARS-CoV-2, influenza and RSV, which may fail to identify potential inequities in its surveillance activities for these pathogens. In comparison, as it relates to outcome indicators, some jurisdictions in the United States (US) report on COVID-19 hospitalizations, intensive care unit (ICU) admissions and mortality by race and ethnicity.[18-21]

Given these strengths and potential limitations, this OPHESAC report on surveillance provides nine evidence-informed recommendations to strengthen Ontario's ability to prepare for, detect, monitor, and respond to established respiratory viral pathogens with epidemic and pandemic potential.

Methods

The Working Group made use of the following sources to generate the nine recommendations in this report: 1) discussions with subject matter experts and key stakeholders; 2) a recent OPHESAC environmental scan for contextual information about surveillance systems within Ontario and other similar jurisdictions;[7] and 3) a recent OPHESAC rapid review focused on optimal approaches to detection of established respiratory viral pathogens for respiratory virus surveillance systems.[6] The OPHESAC scan and rapid review are published in separate documents.[6,7] The Working Group held a series of meetings over the course of several months that resulted in the nine recommendations to provide practical advice

to the Government of Ontario and relevant data partners (e.g., the Office of the Chief Medical Officer of Health, Public Health Ontario, the new branch of Treasury Board focused on Emergency Management, local Public Health Units, Ontario Health and the Ministry of Health) to strengthen Ontario's existing respiratory virus surveillance system. The full OPHESAC committee reviewed and endorsed the recommendations (see Appendix A for a detailed description and approach to developing the recommendations).

In the following section, the nine evidence-informed recommendations are reported in turn with accompanying knowledge and evidence gaps, rationale, supplementary evidence, and key considerations. A list of terms is described in the glossary.

Early Warning, Alert, and Response Systems

Recommendation

We recommend that the Government of Ontario maintain and further invest in an early warning, alert, and response system (EWARS) to prepare for and mitigate the impact of annual respiratory epidemics involving established respiratory viruses: SARS-CoV-2, influenza, and RSV.

Current Gaps

SARS-CoV-2, influenza, and RSV were identified as priority pathogens by the Office of the Chief Medical Officer of Health in its most recent report.[5] These pathogens are important to track, given their substantial population-level impacts, including the potential for pandemic spread of influenza A and SARS-CoV-2. However, the fall 2022 surge in influenza and RSV demonstrated challenges in Ontario's existing EWARS system to provide timely warning for an earlier-than-normal seasonal onset and monitoring of trends in severity and uptake of key interventions, for example influenza vaccines, particularly among risk groups. In Ontario, the substantial wave of influenza and RSV occurred more than a month ahead of their typical seasonal schedule and at higher-than-expected levels of transmission. This contributed to a significant burden on an unprepared healthcare system; for example, the number of children and youth presenting to emergency departments with respiratory virus complaints nearly tripled over the expected seasonal average.[14]

Rationale

The COVID-19 pandemic experience provided lessons to establish an EWARS that reflects best recommended practices as articulated by the recent WHO Mosaic Framework.[15] The goals of these best practices are to diversify surveillance activities and develop sustainable surveillance strategies to effectively assess, monitor, and modify multisectoral response capabilities for SARS-CoV-2, influenza, RSV, and other respiratory viruses of epidemic and pandemic potential. Ontario should continue its investments and improvement activities in respiratory viral surveillance to build on lessons learned during the COVID-19 pandemic.

Relevant Evidence

The early warning, alert and response capability is a critical requirement of the International Health Regulations (2005) core capacities and serves to prevent the emergence of or mitigate the impact of a future respiratory pandemic.[22] This includes the strengthening of coordinated surveillance systems in health care and community settings throughout the year and at the animal-human interface (see Recommendation #2). The newly established WHO Mosaic Framework (2023) is designed to be specific

and adaptive, allowing for more responsive surveillance of respiratory viruses.[15] Surveillance during the COVID-19 pandemic evolved to reflect best recommended practices as articulated by the WHO Mosaic Framework to effectively detect, monitor, and inform the use of key interventions and their uptake, especially amongst high-risk groups, as a means to evaluate if responses are being appropriately targeted.

Key Considerations

- Surveillance data are critical to understanding outbreaks, community and clinical burden, and social determinants of health that impact transmission dynamics of infections, such as heterogeneity in ages and immune status, transmission networks, environmental context and occupations (see Recommendation #7).
- The Office of the Medical Officer of Health, Public Health Ontario, and other relevant ministries, institutions, and community partners, in collaboration with federal partners, should establish joint frameworks to facilitate cross-organizational data collection and sharing to enable a respiratory virus surveillance data supply chain and analyses that considers not only acute impacts on respiratory health, but also wider impacts on population health and socio-economic disparities (see Recommendation #3).[23]
- Maintaining investment in EWARS is necessary at the provincial and federal levels to support its infrastructure for respiratory viral surveillance but is not sufficient alone to inform future pandemic planning and preparedness. Additional tools are required that are captured in the WHO Mosaic Framework for detecting, assessing, and evaluating novel variants, as seen with SARS-CoV-2 and outlined in Recommendation #7.[15]
- It is essential that the early warning component is used to inform public health response.
- More research is required to evaluate the impact of an EWARS system on identifying and reducing health inequities.

Animal-Human-Environmental Interfaces

Recommendation

We recommend that the Government of Ontario ensure coordination of surveillance that promotes a One Health approach integrated at animal-human-environmental interfaces to support the detection of novel variants of respiratory viruses and the emergence of new zoonotic threats.

Current Gaps

There are reporting and response mechanisms for reportable pathogens in animals, however these do not include all relevant zoonotic pathogens and are not structured to include emerging threats. Furthermore, animal-based surveillance is different for different animal sectors, and some surveillance systems rely on veterinarians to report positive tests in mammals to public health, contributing to gaps in data, accountability and responsibility for a coordinated effort when a pathogen is identified in these species. Given the lack of understanding of the scope of activities and lack of coordinated surveillance and response, there is a need to clearly define roles, responsibilities and provide resources for "blind spots" in the current respiratory viral pathogen surveillance system.

Rationale

Early detection of respiratory viral diseases in animals and humans has the potential to prevent or mitigate outbreaks but requires the coordination of surveillance and response with human, animal and environmental health partners that are accountable to different government ministries. An integrated approach is essential to informing the early warning part of the surveillance system and has additional benefits in improving food safety and security, reducing public concern, reducing antibiotic use and resistance and protecting global health security.[5]

Relevant Evidence

Novel pathogens often emerge from animals, with new variants of established pathogens often having zoonotic reservoirs with spillover and spillback of human viruses (e.g., influenza A H5N1 from birds, SARS-CoV-2 infection of deer).[26] While some surveillance efforts such as those related to avian influenza are functioning very well, there are several opportunities to strengthen integration and sharing of data across other animal species, e.g., integrating and sharing of data for wild, companion and food animal testing, to detect novel variants of established priority pathogens and the emergence of new zoonotic threats.[15]

Key Considerations

- Climate change is altering the human-animal-environment ecosystem, and these changes are disproportionately borne by communities living with socioeconomic inequities.[24]
- The designation of a central coordinating organization with a mandate to facilitate integration and collaboration of efforts across different organizations, will strengthen Ontario's One Health approach to respiratory viral pathogen surveillance. One such organization would be Public Health Ontario; however, Ontario may designate another agency in their approach.
- Alternatively, Ontario may consider following the global model of One Health as a quadripartite partnership between public health, animal health, environment, and food and agriculture, with different leads and a Joint Action Plan and expert panel to guide the work of the four partners.[25,26]

Health Equity

Recommendation

We recommend that the Government of Ontario reduce inequities in public health surveillance, including inequities in access to testing, data collection, and inequities in sharing of information and benefits generated by such activities.

Current Gaps

At present surveillance is not equitable as testing approaches vary substantially across the province. Current funding, human, and laboratory resources, and limited coordination in sharing of data serve as barriers to acquisition of high-quality information necessary for optimal respiratory viral surveillance activities. These barriers contribute to inequities within Ontario's surveillance system, including acute and non-acute healthcare settings such as hospitals and other relevant actors, as well as long-term care homes, provincial and federal correctional facilities, shelters, schools, other essential workplaces, and those with limited existing resources (e.g., those in North and near-North regions).

Rationale

Adequate resources are required for local-level surveillance across the province to understand patterns of viral activity and burden of illness towards informing equitable clinical and/or public health responses. Local-level surveillance strategies should be strengthened by enhancing local diagnostic capacity (i.e., to reduce geographic inequities in access to testing), including scaling up of surveillance activities during periods of high community prevalence, and by integrating networks of syndromic, laboratory, and health services-based surveillance.

Relevant Evidence

There is evidence from Ontario early in the COVID-19 pandemic that incorporating socio-demographic data helped reduce inequities, as measured by COVID-19 case-rate ratios, and helped inform a more equitable public health response. Toronto Public Health started collecting race/ethnicity, income and housing data in May 2020. In July 2020, Toronto announced public health responses in hard-hit areas to improve equity in the pandemic response. These actions included community based multi-lingual public health campaigns, community testing and pop-up testing sites, free masks, free voluntary isolation sites, eviction prevention advocacy, food security programs, free digital access and emergency child-care. In June 2020, the Latino population had the highest COVID-19 case-rate ratio compared to the White population but this decreased starting in July 2020.[27] Similarly, the case-rate ratio in the Black population also decreased throughout 2020. Modelling work from Ontario also informed Ontario's COVID-19 vaccination strategy, showing that prioritizing hotspots and essential workers would prevent considerably more COVID-19 hospitalizations, ICU admissions and deaths.[28,29]

Key Considerations

- Activities (e.g., inequities in who is included in surveillance activities, who has the capacity for surveillance, and who bears the burdens of surveillance) and sharing and benefits (e.g., who does and does not have access to surveillance data and who does and does not benefit from surveillance activities) need to be defined.
- The term 'communities' should be interpreted in myriad ways, including geographic communities, communities who share traditions, values, or a common identity, and communities sharing a health condition, for example.
- Strategies to generate surveillance data and monitor respiratory viral illness for groups or communities at higher risk of adverse outcomes (due to biological or social factors) should be engaged before surveillance activities begin to minimize risk of health and social harms. This strategy will require meaningful community engagement to strengthen partnerships and ensure the values and concerns of communities are taken into account when planning, implementing, and using surveillance data.
- Engagement of communities such as Indigenous populations who have been historically marginalized to participate actively in such activities may require additional dedicated resources to support these efforts (see Recommendation 4).
- The results of surveillance activities and implications for corresponding public health measures and policies should be communicated clearly and in a timely, transparent, evidence-based and action-oriented manner to relevant target audiences, including those targeted and impacted by such activities, to inform local, regional, and provincial responses.

First Nations Communities

Recommendation

We recommend that the Government of Ontario strengthen First Nations communities' ability to obtain and use relevant public health data to inform local respiratory viral surveillance strategies, local public health and hospital preparedness, and timely response to outbreak investigations in partnership with provincial and federal health authorities.

Current Gaps

At present, many First Nations communities and local/provincial/federal public health authorities often do not share essential information in a timely manner, resulting in poor surveillance programs. Because of major coordination, data sharing, and service gaps, a health data accountability framework needs to be co-developed with First Nations communities as custodians of their health data.

Rationale

Indigenous data sovereignty principles, such as the First Nations principles of ownership, control access and possession (OCAP), Manitoba Métis principles of ownership, control, access and stewardship (OCAS) and Inuit Qaujimajatuqangit assert that First Nations, Inuit, and Métis communities have a right to data that identify their people or communities, and a right to determine the use of those data in ways that support health and self-determination.[30] While engagement with federal, provincial and local public health authorities is more specific to First Nations communities, data sovereignty applies to all First Nations, Inuit, Metis, and Urban Indigenous peoples in Ontario.

Relevant Evidence

There is evidence that within Ontario, many Northern, near-Northern and marginalized urban communities face constraints around access to primary and specialty health care, access to testing and results, and reliable supply chains; First Nations communities face the added complexity of jurisdictional oversight from federal health authorities within a broader provincial health authority that contribute to challenges in high-quality surveillance programs. Urban Indigenous Peoples also need to participate in the determination of their inclusion and identification in surveillance systems, in keeping with the Tri-Council Policy Statement 2 and recommendations from the Truth and Reconciliation Commission.[31,32]

Key Considerations

- Respiratory viral surveillance programs involving Indigenous communities may look different from one another based on local factors such as population health needs, access to testing and results, access to acute and specialty care, and the presence of an environmental surveillance program.
- One approach to the use of Indigenous-driven surveillance data in informing response may be to have pre-defined, locally determined thresholds of sentinel clinical and environmental signals to enhance community-based surveillance efforts, such as respiratory viral testing, as well as health system responses, such as increasing staffing, bed capacity and access to transport to facilitate transfers to centres with subspecialty care.

Data Governance

Recommendation

We recommend that the Government of Ontario adopt principles of data governance, as outlined by the Canadian Health Data Charter[33] and Ontario Health Data Council Report,[34] to integrate and standardize data collection across health and laboratory systems.

Current Gaps

There are major ongoing shortcomings in information management that prevent existing information and testing already being collected to be used by all health partners and decision makers. This inability to gather, coordinate, analyse and prepare useful data will not be sufficiently addressed without substantial coordinated investment in governance, policy, interoperability, data literacy and public trust (as noted in Recommendation #9) to strengthen the health data foundation and governance.

Rationale

In recognition of health data as a strategic asset and public good, data governance is critical to ensuring person-centric health information design, access, and use. This includes ensuring quality, security, and privacy of health data to maximise benefit and reduce harm to individuals and populations.

Relevant Evidence

Timely access to quality health data enables research into and support of individual health needs, and quality health programs and services to advance health and equity outcomes for individuals, communities, and populations.[35] The Canadian Health Data Charter, Ontario Health Data Council Report and partnerships between Ontario's ICES and diverse Indigenous organizations and communities provide guiding principles to strengthen overall and Indigenous health data governance towards improving individual, community, and population health outcomes in Ontario.[36] An example of a public health surveillance system strengthened through the use of open data is the Behavioral Risk Factor Surveillance System (BRFSS). Since its inception in 1984, public health officials in the US have used BRFSS for real-time monitoring and response to public health emergencies, including the effects of Hurricane Katrina in 2005, H1N1 vaccine uptake during the 2009 influenza pandemic and more recently drought-related threats to public health.[37] It has been completely open access since 2014.

Key Considerations

- Investments in resources and leadership is required to ensure the principles of data governance are feasible to implement.
- The added advantage of the Canadian Health Data Charter lies in its portability across provinces and territories, suggesting a future state of improved health data design, stewardship, interoperability, access and portability across jurisdictions.

Data Sharing

Recommendation

We recommend that the Government of Ontario streamline data sharing processes and policies to enhance the usefulness of and access to surveillance and relevant health and socio-demographic data.

Current Gaps

Relevant laboratory, health care, public health, and socio-economic data are currently siloed. Restrictive data sharing policies do not allow for timely access to data to support evidence-informed respiratory virus mitigation measures considering both the broader and long-term impacts on population health and social inequities. Legislation facilitating the sharing of data across trusted institutions will enable a robust cross-sectoral surveillance system.

Rationale

In the current absence of a single organization mandated with this coordination role for provincial surveillance systems, these efforts to enhance cross-institutional surveillance will continue to be slow to progress and result in unnecessary blockages. To streamline these activities and prevent friction, a central coordinating organization should be tasked as the chief data steward, serving as a point of contact with existing data contributors to this integrated respiratory virus surveillance system data supply chain, including (but not limited to) Canadian Institute for Health Information (CIHI), the Ministry of Health (MOH), Ministry of Children, Community and Social Services (MCCSS), hospitals, and public health units, as well as other relevant stakeholders, such as hospitals, researchers, community partners, privacy officials and the public.

Relevant Evidence

The Nova Scotia Data Sharing Protocol has accelerated data sharing between trusted health partners from the order of months to days, thereby reducing unnecessary paperwork and facilitating collaborations and timely access to data.[33] In the US, current implementation of the US Trusted Exchange Framework and Common Agreement (TEFCA) and the annual Health Datapalooza meeting bring together institutions and individuals to promote innovative health data partnerships.[38,39] These facilitate a patient-centred focus towards supporting the secure sharing of clinical data with trusted public and private partners, and further minimize barriers in access and use of health data

Key Considerations

- Innovative and equitable respiratory virus surveillance information systems supply chain should also leverage existing data not currently considered in traditional surveillance systems to offer a more robust understanding of population health and social inequities. For example, school absenteeism may provide an earlier indicator of viral transmission compared to syndromic or clinical surveillance data.[6]

- Linkages to socio-demographic data, including occupation, race and ethnicity, neighbourhood, and other relevant socio-economic factors, will support surveillance efforts in improving population health and reducing health inequities (see Recommendation #3).

- Specific solutions exist to overcome hurdles in access to timely surveillance data. These solutions include the automation of data cleaning and sharing processes, and standardization of data sharing agreements that will further improve timely access, while ensuring this is done safely and responsibly. These efforts will enhance the utility and access of Ontario's surveillance data to inform timely public health decision-making and health system modeling, while reducing unnecessary administrative and data management demands. These potential solutions are proposed in addition to the solutions offered through the adoption of the Canada Health Data Charter (Recommendation #5).[33]

- Given its existing role in facilitating the cross-institutional use of respiratory virus surveillance data during the COVID-19 pandemic and scientific expertise related to respiratory virus surveillance, the Ministry of Health may consider including the role of chief data steward within the mandate of Public Health Ontario, for example.
- Protocols should be in place and followed to ensure an appropriate balance between data sharing and privacy, including de-identification of data, restricted access to trusted institutions and individuals with clearance, and compliance with Personal Health Information Protection Act requirements.[40]
- Although ownership of health data is complex with multiple entities involved there is a need for these data sharing processes to occur at the federal level so as to integrate provincial human, animal and environmental data streams (see Recommendation #2) and strengthen meaningful surveillance across provinces and territories.

Efficiency of Information Systems

Recommendation

We recommend that the Government of Ontario reduce fragmentation and redundancies to harness the value of existing laboratory, public health and clinical syndromic information systems, to improve timely reporting of viral trends both locally and provincially.

Current Gaps

Fragmentation across information systems such as the Ontario Laboratory Information System, electronic health records and public health databases encourages duplication of efforts and limits the ability of multi-sectoral stakeholders to obtain a comprehensive, real-time picture of respiratory virus trends and disease burden at both provincial and regional levels. This fragmentation makes it difficult to interpret and act upon relevant data in a timely manner. Integration of existing health information systems during the COVID-19 pandemic demonstrated the complementary value of laboratory, public health and syndromic surveillance in understanding the transmission dynamics of SARS-CoV-2 in the population. However, access to testing and integration of results for influenza and RSV remains restricted and siloed. Federal, provincial, and regional surveillance systems can have redundant or overlapping reporting structures, which can compromise population-level risk analyses, communication and effective policy-making.

Rationale

Timely aggregated and integrated syndromic, laboratory and public health data are crucial to understanding transmission dynamics and clinical burden towards informing public health and healthcare system responses. Surveillance needs to be timely and efficient, appropriately validated, and widely shared across sectors with local and provincial decision-makers. Surveillance for clinical syndrome detection and monitoring could include data from Primary Care and Emergency Department visits, hospital admissions, admissions to ICU and deaths.[41,42] It may include community antiviral sales by pharmacies, or absenteeism in schools or workplaces.[43,44] Surveillance system scale up should be bidirectional, such that clinical surveillance indicators of increased respiratory activity would lead to enhanced laboratory testing and other measures to understand, model, and mitigate surges of respiratory illness. Conversely, increased laboratory identification of sentinel viruses would lead to increased clinical and outbreak surveillance and preparation.[45]

Relevant Evidence

Evidence suggests that syndromic data could detect seasons or outbreaks of respiratory viruses earlier or at the same time as laboratory confirmed case data, using clinical syndromic surveillance sources such as ambulance and 911 dispatch calls, primary care and Emergency Department visits, hospitalizations.[6]

Key Considerations

- Surveillance for SARS-CoV-2, influenza, RSV, and for other respiratory viruses should include collection and integration of data from clinical settings, outbreaks, laboratory testing, and wastewater monitoring (see Recommendation #8). This will enable improved preparation and surge response which will affect clinic and hospital staffing, availability of surge beds including increased ICU capacity, expanding and enhancing laboratory capacity and infection prevention and control measures, and increased vaccination and treatment.
- Sequencing of SARS-CoV-2 has played a major role in the detection and monitoring of variants of concern. Combining variant data from travel and locally acquired infection in a timely manner is needed to enhance its utility, and information regarding the feasibility and utility of sequencing influenza and other priority viruses is being explored internationally and should be evaluated in Ontario. Benefits of sequencing include tracking the adaptation, evolution, and mutation of pathogens with epidemic and pandemic potential. Viral characterization and sequencing is also critical to the research and development process that leads to diagnostics, therapeutics, and vaccines.[46]
- While complementary, laboratory, syndromic and outbreak management platforms are likely to underestimate disease burden due to biases in healthcare access and resource use, particularly among marginalized and lower-income communities who have prevailing inequities in healthcare.

Wastewater-Based Surveillance

Recommendation

We recommend that the Government of Ontario continue wastewater-based surveillance for SARS-CoV-2, and evaluate its role for influenza and RSV, for early virus detection and identification of variants of concern, to reduce existing inequities in clinical surveillance.

Current Gaps

A strategy employing isolated clinical surveillance provides limited insights into population-level transmission dynamics and disease burden, particularly in areas with low disease incidence, low population density, and/or limited access to timely testing. Unlike SARS-CoV-2, influenza and RSV surveillance strategies continue to rely on lagging clinical indicators of hospitalization and laboratory test positivity, the latter restricted primarily to individuals requiring hospitalization. There is a need for continued investment in sentinel sites for wastewater surveillance in the upcoming respiratory season to better understand dynamics of co-circulating SARS-CoV-2, influenza and RSV in the population. These insights can inform actions that can prevent or mitigate anticipated health impacts.

Rationale

Wastewater sampling is a population-based tool for respiratory viral surveillance that is independent of individual access to and uptake of testing and health resources.[16]

Relevant Evidence

Wastewater testing and monitoring has played a critical role in Ontario and globally as an early warning signal of emergence of a pathogen (e.g., mpox) or pathogen-related variants of concern (e.g. Omicron variant of SARS-CoV-2), preceding waves of clinical activity by one to two weeks, as well as surges in demand for healthcare services (SARS-CoV-2, influenza A, RSV) in the population.[47-49] During the COVID-19 pandemic in Ontario, wastewater data were used by most public health units to monitor viral shedding trends over time and as an early indicator of changes in incidence, particularly following the reduced availability of SARS-CoV-2 clinical testing at the end of 2021.[50,51]

Key Considerations

- Real-time wastewater surveillance for pathogen trends may reduce inequities that exist in traditional models of clinical surveillance as they relate to testing access, timely reporting and hospitalization events.[52] During the COVID-19 pandemic, wastewater testing in urban neighbourhoods, rural areas, Indigenous communities, and in congregate living settings such as long-term care homes and shelters informed clinical surveillance strategies in and collaborations with populations with disparate access to health services.[50,53,54]
- Rural areas not connected to sewerage systems can have barriers reduced to participation in environmental surveillance strategies with additional infrastructure supports and adapted sampling protocols.
- A sustainable, widespread, geographically representative wastewater surveillance program relies upon strong interdisciplinary collaboration among stakeholders in public health, environment, academia and community leadership, for implementation, integration with clinical surveillance systems, data analysis and interpretation for communication and actionable results.[55]

Access to Health Information

Recommendation

We recommend that the Government of Ontario enhance public reporting by promoting timely access to meaningful and comprehensive health information by the public, decision makers, researchers, and the health workforce.

Current Gaps

A main limitation of Ontario's system is the lack of public reporting, which has also been noted in many other jurisdictions. For instance, there is no documented or publicly available document that outlines ramp-up and ramp-down processes for testing and other surveillance activities in the case of a detected epidemic or pandemic.[7]

Rationale

Public health surveillance data can be considered a public good.[56] It is a foundational asset that increases the efficiency and effectiveness of the public health system through the timely sharing of data. Doing so increases capability to use data for action among all health data users including the public, decision makers, researchers, and the health workforce to inform health policy and practices.

Relevant Evidence

During the COVID-19 pandemic, Ontario's open data initiatives made information about COVID-19 more transparent, and enabled researchers and scientists, including modelers, to develop analyses and models to support decision makers in introducing public health measures.[57] Additional benefits of public reporting may include improved uptake and adherence to public health measures by the public, although evidence for this remains limited.[58,59]

Key Considerations

- Public reporting must be guided by ethical considerations and public engagement to identify opportunities to improve surveillance indicators that are meaningful to communities and populations, and to ensure appropriate precautions are taken to protect the privacy of public reported data and minimize the risk of identifying and potentially stigmatizing marginalized communities.
- Transparent reporting of health data will improve interpretation in a way that provides meaning and supports a proactive cross-sectoral approach. This will allow planners and decision-makers from different sectors, organizations, and institutions to mitigate risk and develop innovations to support pro-social and pro-health practices more proactively.
- Synthesis and interpretation of publicly reported surveillance data by a dedicated public health organization remains essential to the public health decision-making process and corresponding implementation of relevant policies, while simultaneously allowing for transparent reporting to the public to enhance trust in decision-makers.
- Surveillance data should be made available to the public in near real time, with added layers of intelligence that assist in interpretation (e.g., summary of data by person , place and time) while striking a balance with timeliness and available resources to collect analyze, interpret and disseminate health data.

Interpretation

Our nine recommendations for the Government of Ontario focus on solutions that may be implemented in full or in part in anticipation of the fall 2023 seasonal surge of respiratory viral illnesses. The SARS CoV-2 pandemic has taught us many lessons including how to undertake coordinated surveillance programming. Learning from, strengthening, and investing in the many surveillance approaches would be a welcomed addition to the system. The pandemic and recent experiences with three prevalent respiratory viruses also confirmed that we need to continue our current investments. We were also reminded that there are major inequities, inefficiencies in testing and reporting and especially a lack of data visibility and sharing of critical information (testing that is reported and not collated or shared). To ensure our recommendations result in measurable change, Government should conduct a review of all currents system assets (all clinical and laboratory testing as well as syndromic surveillance programs)

and identify important system gaps. Armed with this knowledge, Government can use our recommendations to inform future work and collaborations to improve the system components and its coordination, towards minimizing inefficiencies and ensuring that the system is equitable. Additional human, infrastructure, and financial resources will be required to strengthen Ontario's existing surveillance system. However, a focus on improving existing system efficiency will likely offset the need for substantial sustained investments, and instead require a redistribution of existing resources.

Turning Recommendations into Meaningful Results

Historically, much of surveillance has been opportunistic, i.e., conducting testing where resources are plentiful rather than purpose-built to fully understand the dynamic spread of respiratory viruses in all regions and populations, especially communities at highest risk. The needs of the health system as a whole, which includes public health, community and healthcare partners, should be considered in the short- and long-run in any system redesign. A focus on improving existing system efficiency, equity and coordination will likely offset the need for substantial investments, and more likely require a redistribution of existing resources. There are multiple reasons this strategic approach represents a strong next step in improving ON's overall surveillance system.

For one, Ontario already has several essential and complementary components of a high-quality surveillance system for respiratory viral illnesses; these recommendations seek to find ways to get them working more efficiently together and build on lessons learned from surveillance of individual pathogens in the application to others (Recommendations 1, 5,7).

Second, there are important lessons to be learned from the surveillance experiences and actions of other similar jurisdictions in Canada and around the world. For example, several jurisdictions successfully implemented the use of common data protocols for respiratory viral surveillance.[33,38] Such protocols explicitly outline expectations for the standardization, sharing and use of data, clarify accountability and processes for accessing data, and clarify relevant protections to ensure confidentiality (Recommendations 4, 5).

Third, maintaining current surveillance programs and establishing central organization(s) to integrate, coordinate, and synthesize collection and public reporting of these data will set a strong foundation for future expansion of surveillance activities. The formation of strong partnerships with community and Indigenous leaders, academic experts and institutions will support sustainable innovation and research activities to discover and validate novel approaches to respiratory viral surveillance; these include the collection and reporting of additional health and social outcomes using artificial intelligence and natural language processing, and the use of wastewater for surveillance of other respiratory and non-respiratory pathogens (Recommendations 2, 3, 6, 8, 9).

Our recommendations do not represent a detailed implementation plan but serve as focal points for addressing shortcomings and inefficiencies that require strong federal, provincial/territorial and local collaboration (particularly Recommendations 1, 2, 4, 5, 6). Some of the recommended areas to maintain or strengthen, such as the wastewater infrastructure (to maintain SARS-CoV-2 testing and develop RSV testing beyond 2023), are designed to reduce duplication of efforts within and across federal and provincial surveillance and to improve the use of and access to critical information to reduce inequities in surveillance activities and response.

Improving the Surveillance System to Improve Health for all Ontarians

Addressing inequities in Ontario's surveillance system is aligned with the strategic direction outlined in the annual report from the Office of the Chief Medical Officer of Health, which states, "the public health sector has a responsibility to assess the health of the population, identify health inequities, and work with partners and governments to implement interventions to reduce those inequities."[5] Major equity-related issues remain entrenched within Ontario's respiratory viral surveillance system following a pandemic that saw an unequal impact of COVID-19 on communities in Ontario.[60,61] Some of these issues include geographic and sociodemographic inequities in access to testing and healthcare resources, and data collection and sharing across different stakeholders, knowledge users and care settings to better understand population health and transmission dynamics, in partnership with community leaders. Given the complexity of how a high-quality surveillance system is constructed and organized, it is imperative to have surveillance in at-risk communities co-developed with these communities, with additional resources to address existing gaps. This focus on improving Ontario's surveillance system by reducing existing inequities should be a priority for future work and would further support broader disease surveillance efforts.

Implementation

Many important issues must be considered when planning the implementation of the recommendations contained within this report, including evaluation of the implementation process and evolving surveillance systems. The most important issue may be the presence of pandemic fatigue that risks political divestment in current highly functional elements of Ontario's surveillance system such as its wastewater monitoring capabilities and depreciation of laboratory, clinical and public health system improvements in data collection, coordination and equity as top priorities. It is essential to recognize that addressing complex issues within a large surveillance system for more than 14 million people, with multiple stakeholders is very challenging to fix and will invariably take time and concerted efforts by all responsible for it. This report's recommendations intend to strengthen Ontario's surveillance capabilities by addressing some of its existing limitations and gaps as an initial step for the upcoming anticipated respiratory viral season.

Evidence

The majority of the Working Group indicated that implementation of all nine recommendations except for recommendation #3 would favor or probably favor the recommendation in achieving its intended goals. The perceived effect of implementation of recommendation #3 was unclear largely due to limited availability of evidence for the purposes of these deliberations. However, there was broad recognition that widespread inequities exist within the current system and that these inequities are linked to adverse health outcomes.

Certainty

The majority of Working Group members reported variable levels in the certainty of the evidence across all 9 recommendations. These were as follows: 1) moderate certainty evidence for recommendations 1, 4, 5, and 7; 2) low to moderate certainty evidence for recommendation 8; 3) low certainty evidence for recommendation 9; and 4) very low to low certainty evidence for recommendations 2, 3 and 6.

Equity

The majority of the Working Group perceived that current inequities in Ontario's surveillance system would likely be reduced following implementation of recommendations 4, 7, and 9. Conversely, they expressed the potential for significant variation and uncertainty related to the effects of implementing recommendations 1, 2, 3, 5, 6, and 8 on equity. This derived from potential variation and uncertainty in how the information obtained through surveillance was linked to responses, including the introduction of public health measures to mitigate harms associated with respiratory viral illnesses.

Feasibility

The majority of the Working Group perceived that all nine recommendations, except for recommendation #3, were generally agreed upon to be feasible to implement. It was specifically noted that recommendation 2 will require substantial collaboration and resources to implement. There was uncertainty expressed by the Working Group on the feasibility of implementing recommendation 3, which may have been related to the recommendation as a statement of principle and strategic programmatic direction rather than a specific measurable intervention per se.

Acceptability

The majority of the Working Group perceived that all nine recommendations except for recommendation #9 would be generally acceptable to stakeholders to implement. There was uncertainty expressed by the majority of Working Group on the perceived acceptability of implementing recommendation 9, which was related to the perception that transparent reporting of surveillance data carries potential political sensitivities.

Evaluation

Evaluating the processes and outcomes of implementation poses its own set of challenges. In some cases, our recommendations focus on the initial steps of an overall longer-term strategy to establish and strengthen strong foundations for Ontario's respiratory viral surveillance system. For example, the use of common data protocols and frameworks will likely require multiple funding cycles and years to implement; however, the COVID-19 pandemic demonstrated that investing in data system integration can drastically improve the effectiveness and timeliness of public health and health system decision-making and, thus, population health equity.[57]

Here, the use of a framework to guide evaluation of implementation, such as the RE-AIM Framework may be helpful.[62] Specifically, evaluation may centre on five key domains with a goal to facilitate translation to practice, emphasize representativeness and equity, and address multi-level contextual factors at individual, organizational, and system levels. The first domain evaluates the reach of the recommendation by identifying who is intended to benefit from the proposed recommendation and then study who benefited from it. The second domain evaluates the effectiveness of the recommendation in achieving its intended benefit, while simultaneously measuring the likelihood of negative outcomes related to it. The third domain measures the adoption of a recommendation across all relevant sectors within Ontario's surveillance system to identify who did and who did not apply it. The fourth domain evaluates how a specific recommendation was adapted to fit local context, the additional costs associated with its implementation, and how the results were achieved. The last domain evaluates maintenance of the recommendation. This includes when the intervention became operational; how long it was sustained across the system; and how long the intended benefit and potential harms are sustained. Engaging in a methodical approach to evaluation will allow robust

measurement of success and identify further opportunities to improve implementation where issues are identified through this evaluative process.

Future Directions

In our environmental scan and evidence review, we identified a series of knowledge gaps that are important to highlight.[6,7] Early warning signals from wastewater were recognized to be at the population level, however transmission dynamics may look different according to risk context. As such, improving the spatial resolution of early warning signals from the population level to at-risk built environments, e.g. congregate care setting, can inform public health, clinical and community actions.[63] There are questions around return on investment for specific elements and activities within the surveillance system, including wastewater sampling which is not universally available across Ontario. Economic analyses should take into consideration the benefits to local public health and healthcare systems through community and academic partnerships, and social justice impact.[50,54,64]

There remain questions around defining thresholds for early warning signals and alerts that would efficiently and transparently turn the system on and off. Importantly, there is a need to ensure that a system that analyses equity indicators is a system linked to equitable responses rather than exacerbate existing inequities. Crucially, it is important to make surveillance activities more visible to the public and demonstrate that investments into transparent public reporting yield effective risk communication and uptake of public measures.

Future priorities that were raised by the Working Group and OPHESAC Committee included an in-depth review of where inequities are most pervasive within Ontario's current surveillance system, alongside a gap analysis of clinical, laboratory and environmental surveillance capacity for specific populations and communities, and evidence review to identify effective approaches and interventions to reduce inequity in surveillance; a detailed action plan to guide implementation and evaluation of this report's nine recommendations; and strengthening Ontario's ability to detect novel pathogens in the context of increasing globalization and climate change; and identifying optimal methods to build coordinated One Health surveillance systems. Importantly, as health data are a public good, modern data visualization techniques and knowledge translation should be employed to promote clearer and more effective communication to the public of emerging health threats and pathogen trends. Such efforts rely on engagement of relevant stakeholders in communities, health, academia and government to understand potential barriers and facilitators of surveillance activities at the local and regional level.

References

1. World Health Organization (WHO). Statement on the fifteenth meeting of the IHR (2005) Emergency Committee on the COVID-19 pandemic [Internet]. Geneva: WHO; 2023 [cited 2023 Jul 20]. Available from: https://www.who.int/news/item/05-05-2023-statement-on-the-fifteenth-meeting-of-the-international-health-regulations-(2005)-emergency-committee-regarding-the-coronavirus-disease-(covid-19)-pandemic
2. Tamerius J, Nelson MI, Zhou SZ, Viboud C, Miller MA, Alonso WJ. Global influenza seasonality: reconciling patterns across temperate and tropical regions. Environ Health Perspect. 2011;119(4):439-45. Available from: https://doi.org/10.1289/ehp.1002383
3. Zheng L, Lin Y, Yang J, Fang K, Wu J, Zheng M. Global variability of influenza activity and virus subtype circulation from 2011 to 2023. BMJ Open Respir Res. 2023;10(1). Available from: https://doi.org/10.1136/bmjresp-2023-001638
4. Hawkes MT, Lee BE, Kanji JN, Zelyas N, Wong K, Barton M, et al. Seasonality of respiratory viruses at northern latitudes. JAMA Netw Open. 2021;4(9):e2124650. Available from: https://doi.org/10.1001/jamanetworkopen.2021.24650
5. Ontario. Ministry of Health. Being ready: ensuring public health preparedness for infectious outbreaks and pandemics [Internet]. Toronto, ON: King's Printer for Ontario; 2022 [cited 2023 Jul 20]. Available from: https://files.ontario.ca/moh-cmoh-annual-report-2022-en-2023-03-15.pdf
6. Ontario Public Health Emergencies Science Advisory Committee. Approaches to respiratory virus surveillance: a review of the literature. Toronto, ON: King's Printer for Ontario; 2023. Forthcoming.
7. Ontario Public Health Emergencies Science Advisory Committee. Environmental scan: respiratory virus surveillance systems. Toronto, ON: King's Printer for Ontario; 2023. Forthcoming.
8. Hansen CL, Chaves SS, Demont C, Viboud C. Mortality associated with influenza and respiratory syncytial virus in the US, 1999-2018. JAMA Netw Open. 2022;5(2):e220527-e. Available from: https://doi.org/10.1001/jamanetworkopen.2022.0527
9. Zhou H, Thompson WW, Viboud CG, Ringholz CM, Cheng PY, Steiner C, et al. Hospitalizations associated with influenza and respiratory syncytial virus in the United States, 1993-2008. Clin Infect Dis. 2012;54(10):1427-36. Available from: https://doi.org/10.1093/cid/cis211
10. Kuster SP, Böni J, Kouyos RD, Huber M, Schmutz S, Shah C, et al. Absenteeism and presenteeism in healthcare workers due to respiratory illness. Infect Control Hosp Epidemiol. 2021;42(3):268-73. Available from: https://doi.org/10.1017/ice.2020.444
11. McLean HQ, Peterson SH, King JP, Meece JK, Belongia EA. School absenteeism among school-aged children with medically attended acute viral respiratory illness during three influenza seasons, 2012-2013 through 2014-2015. Influenza Other Respir Viruses. 2017;11(3):220-9. Available from: https://doi.org/10.1111/irv.12440
12. Ontario Agency for Health Protection and Promotion (Public Health Ontario). Ontario respiratory pathogen bulletin [Internet] . Toronto, ON: King's Printer for Ontario; 2022 [cited 2023 Jul 12]. Available from: https://www.publichealthontario.ca/en/Data-and-Analysis/Commonly-Used-Products/Respiratory-Pathogens-Weekly
13. Ontario Agency for Health Protection and Promotion (Public Health Ontario). Respiratory virus overview in Ontario: June 25, 2023 to July 8, 2023 [Internet]. Toronto, ON: King's Printer for Ontario; 2023 [cited 2023 Jul 25]. Available from: https://www.publichealthontario.ca/-/media/Documents/nCoV/epi/respiratory-virus-overview-ontario.pdf?rev=86ff91827fe648589cd3b5b8874305f5&sc_lang=en.
14. Crawley M. Triple the usual number of kids are coming to Ontario ERs with respiratory illnesses. Here's why. CBC News [Internet], 2022 Nov 3 [2023 May 9]; Health. Available from:

https://www.cbc.ca/news/health/children-hospital-emergency-visits-admissions-respiratory-1.6638180.
15. World Health Organization (WHO). Mosaic respiratory surveillance framework [Internet]. Geneva: WHO; 2023 [cited 2023 Jul 20]. Available from: https://www.who.int/initiatives/mosaic-respiratory-surveillance-framework
16. Ontario Agency for Health Protection and Promotion (Public Health Ontario). COVID-19 wastewater surveillance update [Internet]. Toronto, ON: King's Printer for Ontario; 2022 [cited 2023 Jul 13]. Available from: https://www.publichealthontario.ca/-/media/documents/ncov/phm/2021/04/public-health-measures-wastewater-surveillance.pdf?la=en
17. KFL&A Public Health. Viral respiratory mapper - ACES ED visits [Internet]. Kinston, ON: KFL&A Public Health; 2023 [cited 2023 Jul 12]. Available from: https://www.kflaphi.ca/viral-respiratory-mapper-visits/
18. Centers for Disease Control and Prevention (CDC). Rates of influenza hospitalization: preliminary cumulative rates as of Apr 29, 2023 [Internet]. Atlanta, GA: CDC; 2023 [cited 2023 May 9]. Available from: https://gis.cdc.gov/GRASP/Fluview/FluHospRates.html.
19. New York State. Department of Health. COVID-19 data in New York [Internet]. New York, NY: New York State; 2023 [cited 2023 May 9]. Available from: https://coronavirus.health.ny.gov/covid-19-data-new-york.
20. New York State. Department of Health. Fatalities [Internet]. New York, NY: New York State; 2023 [cited 2023 May 9]. Available from: https://coronavirus.health.ny.gov/fatalities-0.
21. Michigan Department of Health & Human Services. Michigan mortality statistics [Internet]. Lansing, MI: State of Michigan; 2023 [cited 2023 May 9]. Available from: https://www.michigan.gov/mdhhs/inside-mdhhs/statisticsreports/vitalstats/mortality
22. World Health Organization (WHO). International Health Regulations (2005) – third edition. Geneva: WHO; 2023. Available from: https://www.who.int/publications/i/item/9789241580496
23. Bubela T, Flood CM, McGrail K, Straus SE, Mishra S. How Canada's decentralised covid-19 response affected public health data and decision making. BMJ. 2023;382:e075665. Available from: https://doi.org/10.1136/bmj-2023-075665
24. Landguth EL, Holden ZA, Graham J, Stark B, Mokhtari EB, Kaleczyc E, et al. The delayed effect of wildfire season particulate matter on subsequent influenza season in a mountain west region of the USA. Environ Int. 2020;139:105668. Available from: https://doi.org/10.1016/j.envint.2020.105668
25. Food and Agriculture Organization of the United Nations. Preventing the next zoonotic pandemic. Strengthening and extending the One Health approach to avert pandemics of animal origin in the region [Internet]. Budapest: Food and Agriculture Organization of the United Nations; 2020 [cited 2023 Jul 20]. Available from: https://www.fao.org/3/cb2017en/CB2017EN.pdf.
26. Royal Society of Canada. Strengthening a One Health approach to emerging zoonoses [Internet]. Ottawa, ON: Royal Society of Canada; 2022 [cited 2023 Jul 20]. Available from: https://rsc-src.ca/sites/default/files/OH%20PB_EN.pdf.
27. McKenzie K. Socio-demographic data collection and equity in covid-19 in Toronto. EClinicalMedicine. 2021;34:100812. Available from: https://doi.org/10.1016/j.eclinm.2021.100812
28. Mishra S, Stall NM, Ma H, Odutayo A, Kwong JC, Allen U, et al. A vaccination strategy for Ontario COVID-19 hotspots and essential workers [Internet]. Toronto, ON: Ontario COVID-19 Science Advisory Table; 2021 [cited 2023 Jul 20]. Available from: https://covid19-sciencetable.ca/sciencebrief/a-vaccination-strategy-for-ontario-covid-19-hotspots-and-essential-workers/.
29. Ontario. Newsroom. Ontario's COVID-19 vaccination strategy targets high-risk neighbourhoods [Internet]. Toronto, ON: King's Printer for Ontario; 2021 [cited 2023 Jul 20]. Available from:

https://news.ontario.ca/en/release/61124/ontarios-covid-19-vaccination-strategy-targets-high-risk-neighbourhoods.
30. Canadian Institute for Health Information (CIHI). A path forward: toward respectful governance of First Nations, Inuit and Métis data housed at CIHI, updated August 2020 [Internet]. Ottawa, ON: CIHI; 2020 [cited 2023 Jul 20]. Available from: https://www.cihi.ca/sites/default/files/document/path-toward-respectful-governance-fnim-2020-report-en.pdf.
31. Canadian Institutes of Health Research; Natural Sciences and Engineering Research Council of Canada; Social Sciences and Humanities Research Council of Canada. Tri-Council policy statement: ethical conduct for research involving humans – TCPS 2 (2022). Ottawa, ON: His Majesty the King in Right of Canada, as represented by the Minister of Health and the Minister of Innovation, Science and Industry; 2022. Available from: https://ethics.gc.ca/eng/policy-politique_tcps2-eptc2_2022.html
32. Truth and Reconciliation Commission of Canada. Truth and Reconciliation Commission of Canada: calls to action [Internet]. Winnipeg, MB: Truth and Reconciliation Commission of Canada; 2015 [cited 2023 Jul 27]. Available from: https://publications.gc.ca/collections/collection_2015/trc/IR4-8-2015-eng.pdf
33. Public Health Agency of Canada (PHAC). Expert Advisory Group report 3: toward a world-class health data system [Internet]. Ottawa, ON: Government of Canada; 2023 [modified 2022 May 3; cited 2023 Jul 26]. Available from: https://www.canada.ca/en/public-health/corporate/mandate/about-agency/external-advisory-bodies/list/pan-canadian-health-data-strategy-reports-summaries/expert-advisory-group-report-03-toward-world-class-health-data-system.html
34. Ontario. Ministry of Health. Ontario Health Data Council report: a vision for Ontario's health data ecosystem [Internet]. Toronto, ON: King's Printer for Ontario; 2023 [updated 2022 Dec 29; cited 2023 Jul 26]. Available from: https://www.ontario.ca/page/ontario-health-data-council-report-vision-ontarios-health-data-ecosystem
35. Huston P, Edge VL, Bernier E. Reaping the benefits of Open Data in public health. Can Commun Dis Rep. 2019;45(11):252-6. Available from: https://doi.org/10.14745/ccdr.v45i10a01
36. Pyper E, Henry D, Yates EA, Mecredy G, Ratnasingham S, Slegers B, et al. Walking the path together: Indigenous health data at ICES. Healthc Q. 2018;20(4):6-9. Available from: https://doi.org/10.12927/hcq.2018.25431
37. Centers for Disease Control and Prevention (CDC). Behavioral risk factor surveillance system: history [Internet]. Atlanta, GA: CDC; [cited 2023 Jul 20]. Available from: https://www.cdc.gov/brfss/factsheets/pdf/brfss-history.pdf
38. Academy Health. Health datapalooza [Internet]. Washington, DC: Academy Health; 2023 [cited 2023 Jul 26]. Available from: https://academyhealth.org/blog/topic/health-datapalooza
39. Office of the National Coordinator for Health Information Technology (ONC). Trusted exchange framework and common agreement (TEFCA) [Internet]. Washington, DC: U.S. Department of Health and Human Services; 2023 [cited 2023 Jul 27]. Available from: https://www.healthit.gov/topic/interoperability/policy/trusted-exchange-framework-and-common-agreement-tefca
40. *Personal Health Information Protection Act,* 2004, SO 2004, c 3, Sched A.
41. Knowledge Management. Acute care enhances surveillance: user manual [Internet]. Kingston, ON: KFL&A Public Health; 2020 [cited 2023 Jul 20]. Available from: https://www.kflaphi.ca/docs/ACES-User-Manual_v01032020.pdf.
42. Public Health Agency of Canada (PHAC). Flu (influenza): FluWatch surveillance [Internet]. Ottawa, ON: His Majesty the King in Right of Canada; 2023 [cited 2023 Jul 20]. Available from: https://www.canada.ca/en/public-health/services/diseases/flu-influenza/influenza-surveillance.html

43. Ontario. Ministry of Health. 2022: school absenteeism [Internet]. Toronto, ON: King's Printer for Ontario; 2022 [cited 2023 Jul 12]. Available from: https://data.ontario.ca/dataset/summary-of-cases-in-schools/resource/e3214f57-9c24-4297-be27-a1809f9044ba
44. Manitoba Health. Provincial respiratory surveillance report: COVID-19 and seasonal influenza, 2022-23: week 17 (April 23-April 29, 2023) [Internet]. Winnipeg, MB: Manitoba Health; [2023] [cited 2023 May 9]. Available from: https://www.gov.mb.ca/health/publichealth/surveillance/influenza/index.html.
45. World Health Organization (WHO). Health Data as a global public good – a call for Health Data Governance 30 September [Internet]. Geneva: WHO; 2021 [cited 2023 Jul 26]. Available from: https://www.who.int/news-room/articles-detail/health-data-as-a-global-public-good-a-call-for-health-data-governance-30-september#:~:text=Health%20data%20is%20both%20a,in%20countries%20to%20address%20fragmentation.
46. Halabi S, Wilder R, Gostin LO, Hurtado ML. Sharing pathogen genomic sequence data - toward effective pandemic prevention, preparedness, and response. N Engl J Med. 2023;388(26):2401-4. Available from: https://doi.org/10.1056/NEJMp2304214
47. Wolfe MK, Yu AT, Duong D, Rane MS, Hughes B, Chan-Herur V, et al. Use of wastewater for mpox outbreak surveillance in California. N Engl J Med. 2023;388(6):570-2. Available from: https://doi.org/10.1056/NEJMc2213882
48. Mercier E, D'Aoust PM, Thakali O, Hegazy N, Jia JJ, Zhang Z, et al. Municipal and neighbourhood level wastewater surveillance and subtyping of an influenza virus outbreak. Sci Rep. 2022;12(1):15777. Available from: https://doi.org/10.1038/s41598-022-20076-z
49. Mercier E, Wan S, Mackenzie A, Delatolla R, Thampi N. Application of wastewater surveillance to inform the start of the pediatric RSV season: a tale of two cities in Ontario, Canada. In: CoVaRR-Net Spring 2023 Meeting, Ottawa: May 17, 2023.
50. Hyllestad S, Myrmel M, Lomba JAB, Jordhøy F, Schipper SK, Amato E. Effectiveness of environmental surveillance of SARS-CoV-2 as an early warning system during the first year of the COVID-19 pandemic: a systematic review. J Water Health. 2022;20(8):1223-42. Available from: https://doi.org/10.2166/wh.2022.115
51. Ontario Agency for Health Protection and Promotion (Public Health Ontario). COVID-19 wastewater surveillance survey results [Internet]. Toronto, ON: Queen's Printer for Ontario; 2022 [cited 2023 Jul 20]. Available from: https://www.publichealthontario.ca/-/media/Documents/nCoV/phm/2022/08/covid-wastewater-surveillance-survey-results.pdf?sc_lang=en
52. Naughton CC, Roman FA, Jr., Alvarado AGF, Tariqi AQ, Deeming MA, Kadonsky KF, et al. Show us the data: global COVID-19 wastewater monitoring efforts, equity, and gaps. FEMS Microbes. 2023;4:xtad003. Available from: https://doi.org/10.1093/femsmc/xtad003
53. Akingbola S, Fernandes R, Borden S, Gilbride K, Oswald C, Straus S, et al. Early identification of a COVID-19 outbreak detected by wastewater surveillance at a large homeless shelter in Toronto, Ontario. Can J Public Health. 2023;114(1):72-9. Available from: https://doi.org/10.17269/s41997-022-00696-8
54. Smith KA. Nipissing the initial First Nation on Turtle Island to test wastewater for COVID-19. Anishinabek News [Internet], 2021 Jan 26 [cited 2023 Jul 20]; Health. Available from: https://anishinabeknews.ca/2021/01/26/nipissing-the-initial-first-nation-on-turtle-island-to-test-wastewater-for-covid-19/
55. Manuel D, Amadei CA, Campbell JR, Brault JM, Veillard J. Strengthening public health surveillance through wastewater testing: an essential investment for the COVID-19 pandemic and future health threats [Internet]. Washington, DC: World Bank Group; 2022 [cited 2023 Jul 26]. Available from: https://openknowledge.worldbank.org/handle/10986/36852.
56. Information and Privacy Commissioner of Ontario. Using health data for the public good [Internet]. Toronto, ON: Information and Privacy Commissioner of Ontario; 2023 [modified 2021

Aug 4; cited 2023 Jul 26]. Available from: https://www.ipc.on.ca/using-health-data-for-the-public-good/
57. Hillmer MP, Feng P, McLaughlin JR, Murty VK, Sander B, Greenberg A, et al. Ontario's COVID-19 modelling consensus table: mobilizing scientific expertise to support pandemic response. Can J Public Health. 2021;112(5):799-806. Available from: https://doi.org/10.17269/s41997-021-00559-8
58. Fagerlin A, Valley TS, Scherer AM, Knaus M, Das E, Zikmund-Fisher BJ. Communicating infectious disease prevalence through graphics: results from an international survey. Vaccine. 2017;35(32):4041-7. Available from: https://doi.org/10.1016/j.vaccine.2017.05.048
59. Thorpe A, Scherer AM, Han PKJ, Burpo N, Shaffer V, Scherer L, et al. Exposure to common geographic COVID-19 prevalence maps and public knowledge, risk perceptions, and behavioral intentions. JAMA Netw Open. 2021;4(1):e2033538. Available from: https://doi.org/10.1001/jamanetworkopen.2020.33538
60. van Ingen T, Brown KA, Buchan SA, Akingbola S, Daneman N, Warren CM, et al. Neighbourhood-level socio-demographic characteristics and risk of COVID-19 incidence and mortality in Ontario, Canada: a population-based study. PLoS ONE. 2022;17(10):e0276507. Available from: https://doi.org/10.1371/journal.pone.0276507
61. Srivastava P, Lau NTT, Ansari D, Thampi N. Effects of school-level and area-level socio-economic factors on elementary school student COVID-19 infections: a population-based observational study. BMJ Open. 2023;13(3):e065596. Available from: https://doi.org/10.1136/bmjopen-2022-065596
62. RE-AIM. What is RE-AIM? [Internet]. Omaha, NE: RE-AIM; 2023 [cited 2023 Jul 20]. Available from: https://re-aim.org/learn/what-is-re-aim/
63. Fralick M, Nott C, Moggridge J, Castellani L, Raudanskis A, Guttman DS, et al. Detection of covid-19 outbreaks using built environment testing for SARS-CoV-2. NEJM Evid. 2023;2(3):EVIDoa2200203. Available from: https://doi.org/10.1056/EVIDoa2200203
64. Dowdy DW, Zwerling AA, Stennett A, Searle A, Dukhanin V, Taylor HA, et al. Measuring stigma to assess the social justice implications of health-related policy decisions: application to novel treatment regimens for multidrug-resistant tuberculosis. MDM Policy Pract. 2020;5(1):2381468320915239. Available from: https://doi.org/10.1177/2381468320915239
65. Henning KJ. Overview of syndromic surveillance what is syndromic surveillance? MMWR. 2004:53(Suppl);5-11. Available from: https://www.cdc.gov/mmwr/preview/mmwrhtml/su5301a3.htm
66. Ontario. Ministry of Health and Long-Term Care. Relationship with Indigenous communities guideline, 2018 [Internet]. Toronto, ON: Kings' Printer for Ontario; 2018 [cited 2023 Aug 4]. Available from: https://www.health.gov.on.ca/en/pro/programs/publichealth/oph_standards/docs/protocols_guidelines/Relationship_with_Indigenous_Communities_Guideline_en.pdf
67. *Municipal Act*, 2001, SO 2001, c 25.
68. Ontario Agency for Health Promotion (Public Health Ontario). Ontario public health system: public health history [Internet]. Toronto, ON; Queen's Printer for Ontario; 2020 [cited 2023 Jun 23]. Available from: https://www.publichealthontario.ca/en/About/news/2020/Ontario-Public-Health-System.
69. Schünemann H BJ, Guyatt G, Oxman A. GRADE handbook. London: Cochrane Collaboration; 2013. Available from: https://gdt.gradepro.org/app/handbook/handbook.html

Glossary of Terms

Agencies: Groupings of individuals who mobilize to deliver a service, provide information, and/or advocate or connect with people on a common issue. Agencies may be included in the non-governmental or not-for-profit sectors. This includes congregate settings like shelters and long-term care facilities.

Clinical syndromic information systems: an approach to public health surveillance focused on monitoring disease indicators that are pre-diagnostic (i.e., prior to laboratory confirmation) and are often based on healthcare providers reporting events related to a syndrome (e.g., influenza-like illness).[65]

Gap: The shortfall of knowledge or policy that often contributes to limited understanding of a problem or differential distribution of information and/or resources throughout a system.

Health care institutions: Institutions, including hospitals, chronic care facilities, and health clinics, providing care or treatment to individuals.

Healthcare capacity monitoring: The routine and systematic monitoring of health care capacity and utilization, either through comprehensive reporting or sentinel-based systems, to inform preparedness and response.[15]

Indigenous organizations and agencies: First Nations health authorities, First Nations Provincial/Territorial Organizations, Métis, Inuit, and Federal and Provincial partner tables. These are described in the Ontario Public Health Standards guideline: Relationship with Indigenous Communities Guideline, 2018 (gov.on.ca).[66]

Municipalities: A geographic area whose inhabitants are incorporated, including larger regional governments that take on some roles of smaller local governments.[67]

One Health: An integrated, unifying approach that aims to sustainably balance and optimize the health of people, animals, and ecosystems. It recognizes that the health of humans, domestic and wild animals, plants and the wider environment including ecosystems are linked**.**[15]

Public health units: Local government organizations offering healthy living and disease prevention information and programming to their communities. Public health units are led by a Medical Officer of Health, under the supervision of a local board of health.[68]

Public health surveillance: The ongoing, systematic collection, analysis and interpretation of health-related data essential to planning, implementation and the evaluation of public health practice.[15]

Stakeholders: Organizations and individuals that are affected by and/or respond to respiratory viral epidemics and pandemics.

Sentinel surveillance: Involves a limited number of recruited participants, such as health care providers or hospitals, who report specified health events that may be generalizable to the whole population.[15]

Appendix A. Approach to the Development of Recommendations

Each of the nine recommendations were developed iteratively by the Working Group members. To develop each recommendation, consistent methods were applied as a triangulated approach that included four processes to:

1. Identify and consider the best available evidence, primarily from published literature (i.e., respiratory virus rapid review).
2. Identify and consider contextual information (i.e., a scan of jurisdictions).
3. Utilize the insights from external subject matter experts.
4. Incorporate the Working Group members' collective expertise and experiences.

To develop the nine recommendations, the Working Group members assessed the synthesized evidence from these four processes and engaged in an iterative and collaborative review and refinement process for each. The Working Group reached final agreement on the nine recommendations via a series of dedicated meetings to discuss each recommendation in turn. An Evidence to Decision (EtD) framework-like approach was used to ensure consideration of key criteria for each of the nine recommendations such as evidence, certainty of evidence, equity, acceptability, and feasibility.[69] The Working Group members then rated each of the nine recommendations on those criteria and could provide additional comments to clarify their choice of rating. These ratings were openly discussed at a dedicated meeting among the Working Group members to refine and clarify questions related to them. The final ratings for each recommendation were reported according to the majority response, which was defined as having a two thirds majority (e.g., 'two thirds rated 'yes' on acceptability).

Following the development of the nine recommendations by the Working Group, the entire OPHESAC committee provided two rounds of feedback on each recommendation. For the final consensus, a systematic approach allowed the OPHESAC committee members to indicate their level of agreement with each recommendation.

The Working Group and the OPHESAC committee participated in online meetings to iteratively discuss and agree upon the approaches most appropriate at the time. Of note, important implementation elements, equity concerns, and supplementary evidence were consistently considered and discussed according to the available information at the time of discussion.

The OPHESAC Secretariat conducted the scientific work to provide supplementary evidence in supporting the Working Group's development of the technical report and its nine evidence-informed recommendations. These activities included co-developing the study concepts and designs; acquisition, analysis, and interpretation of the data; drafting of the reports; and providing critical revision for important intellectual content. In addition to the above, the Scientific Director (Dr. Paul Hebert) and Assistant Scientific Director (Dr. Kieran Quinn) provided input and advice on the overall scientific direction and supervision of the scientific methods.

OPHESAC Process to Affirm Recommendations

The process to affirm recommendations by the full OPHESAC Committee began with the Working Group chairs/co-chairs presenting the most recent recommendations to them to highlight key elements. Each presentation was followed by a brief discussion to clarify any points. Subsequently, the OPHESAC Committee indicated their level of agreement (Yes/No) in affirming each of the nine individual recommendations.

The OPHESAC Terms of Reference requires that a two-thirds majority of a quorum (participation of two-thirds of its members) is needed for a recommendation to be affirmed. Therefore, if two-thirds of a participating quorum of the Committee agreed with the recommendation (as written with an allowance for minor edits) then the recommendation was considered approved. Where there was disagreement, the individual recommendation was discussed in further detail in light of the provided feedback in an attempt to improve the overall level of agreement. If major edits were made based on the feedback provided, then both the old and the revised recommendation(s) were subsequently presented for a second round of voting, along with the responses from the first round for reference.

About the Ontario Public Health Emergencies Science Advisory Committee

The Ontario Public Health Emergencies Science Advisory Committee (OPHESAC) is a group of independent, multi-disciplinary experts whose role is to enhance provincial capacity to respond to a spectrum of public health emergencies with the best available evidence. OPHESAC provides independent scientific advice to Public Health Ontario to inform the management of public health emergencies, including COVID-19. For more information about OPHESAC and its members, visit the OPHESAC webpage or contact communications@oahpp.ca.

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Disclaimer

This document was prepared by the Ontario Public Health Emergencies Science Advisory Committee (OPHESAC) for Public Health Ontario. OPHESAC provides evidence-based advice to Public Health Ontario to inform the management of public health emergencies, including COVID-19. OPHESAC work is guided by the evidence available at the time this document was prepared. The application and use of this document is the responsibility of the user. PHO assumes no liability resulting from any such application or use. This document may be reproduced without permission for non-commercial purposes only and provided that appropriate credit is given to PHO. No changes may be made to this document without prior and expressed written permission from PHO.

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