Rapid Scoping Review: What is known about changes to public health surveillance programs, systems and strategies at the population level for governments globally due to the COVID-19 pandemic?

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Executive Summary

Background

The coronavirus disease 2019 (COVID-19) pandemic has increased need for effective public health surveillance and also made some aspects of surveillance more challenging due to mobility restrictions, physical distancing and other infection prevention measures. Globally, the pandemic has driven adaptations to surveillance approaches as well as precipitated the development of new surveillance strategies.

This rapid scoping review was produced to support public health decision makers' strategic planning in the context of the COVID-19 pandemic and recovery. This review seeks to identify and summarize emerging research evidence to support evidence-informed decision making.

This rapid scoping review includes evidence available up to January 25, 2022 to answer the question: **What is known about changes to public health surveillance programs, systems and strategies at the population level for governments globally due to the COVID-19 pandemic?**

Definitions of key terms are included in [Appendix 1](#).

Key Points

- Literature on changes to public health surveillance during COVID-19 (n=244) is dominated by surveillance of COVID-19 infections (n=190). Most describes digital surveillance (e.g., use of big data through mobility tracking and infodemiology, sometimes augmented with artificial intelligence (AI) (n=130); and wastewater epidemiology (n=40). Other methods are designed to supplement limited COVID-19 testing capacity, including analysis of data from various health care settings, e.g., hospitals and blood banks (n=11). Genomic surveillance to detect SARS-CoV-2 variants was also described (n=5).
- Some public health surveillance, such as cancer screening (n=5), child health assessments (n=3), and sexually transmitted infection (STI) screening (n=2) has adapted to mobility restrictions and physical distancing using technology for remote screening.
- Other public health surveillance has leveraged lessons learned through COVID-19 surveillance, such as, applying digital surveillance approaches to monitoring population mental health (n=8), misinformation (n=5), zoonoses (n=2) and using wastewater infrastructures to monitor antibiotic resistance (n=2) and substance use (n=1).
- AI was used to augment digital surveillance (n=34) and in one case, wastewater surveillance.
- One study used Indigenous methods to monitor COVID-19 through a community-focused COVID-19 surveillance program.
- Several studies (n=4) described the development of standardized, digitized data repositories to enable inter-jurisdictional surveillance.
- Surveillance was largely undertaken at the national level (n=77), regional, provincial, territorial or state level (n=55), local level (n=44) or not specifically tied to a level of governance with the potential to be applied at any level (n=70).

- Implications of changes to public health surveillance during the COVID-19 pandemic, from ethical, legal, data security and equity perspectives are discussed in many papers (n=109).
- While scarce, papers on the ethical implications of digital (n=21) and wastewater surveillance (n=2) highlight the potential for inequitable treatment based on surveillance. Health equity is largely overlooked in included literature on public health surveillance methods.

Further Considerations for Changes to Public Health Surveillance Programs, Systems and Strategies: Perspectives of Public Health Epidemiologists

- Two public health epidemiologists working in Ontario provided feedback on the Key Points above. They agreed with findings but also suggested that nearly every surveillance system or program has been impacted by the COVID-19 pandemic. Some programs have been paused due to resource re-allocation. Several key metrics have become difficult or not possible to interpret, e.g., healthcare system utilization as a proxy for population health. It was suggested that these changes may not be captured in academic literature as many professionals working in public health simply do not have the time, energy or academic support to publish their work.
- It was noted that the approach to surveillance of COVID-19 has also changed over the course of the pandemic. There has been observed a general shift from case counts as a key indicator to measures such as hospital and ICU occupancy, reflecting the change in priority from eliminating COVID-19 altogether, but rather to reduce and manage the healthcare system burden.
- While data for equity has been limited, some governments have made efforts to improve equity measures. For example, the Ontario government in 2020 amended its Health Protection and Promotion Act and augmented the provincial Case and Contact Management (CCM) tool to allow for collection of social determinants (e.g., race, income, etc.) for COVID-19 cases. Similar changes were made for COVID-19 vaccine surveillance data.
- It was suggested that significant resources are required to restore public health surveillance systems during pandemic recovery and to improve them by leveraging or investing in better data.

Methods

Scoping review methodology as described by Arksey and O'Malley was used to guide this rapid scoping review (Arksey & O'Malley, 2005).

Research Question

What is known about changes to public health surveillance programs, systems and strategies at the population level for governments globally due to the COVID-19 pandemic?

Search

On January 25, 2022, the following databases were searched using key terms monitor* and surveil*:
- MEDLINE database
- Embase
- Ovid Emcare
- Global Health Database
- PsycInfo
- MedRxiv preprint server
- COVID-19 Living Overview of the Evidence (L·OVE)
- Web of Science
- World Health Organization's Global literature on coronavirus disease
- World Health Organization
- Centers for Disease Control and Prevention
- European Centre for Disease Prevention and Control
- Pan American Health Organization
- Australian Government website
- United Kingdom government website
- Israel Government website
- Denmark Government website

A copy of the full search strategy is available in Appendix 2.

Study Selection Criteria

English- or French-language, peer-reviewed sources and sources published ahead-of-print before peer review were included. Grey literature was also included.

	Inclusion	Exclusion	Rationale
Population	National populations Provincial, territorial, state, regional populations	Individual-level surveillance (i.e., surveillance of an individual)	Interest in population-level surveillance programs and systems Intent of population-level data
Concept	Surveillance programs and systems for outcomes likely to have been directly affected by the COVID-19 pandemic.	Surveillance programs and systems not directly impacted by the COVID-19 pandemic.	Focus on change impacts of COVID-19 pandemic Shifts in how surveillance is being done, in response to COVID-19; COVID-19 as a key driver
Context	COVID-19 pandemic		
Limits	March 1, 2020-present		While COVID-19 cases were identified in December 2019, the search was limited to March 2020 to allow for literature to capture changes in surveillance and reduce the overall results set for this rapid scoping review.

Literature on wastewater epidemiology for COVID-19 was limited to syntheses or single studies that described a novel approach to wastewater surveillance. Case reports of wastewater epidemiology for COVID-19 were excluded.

Data Extraction and Summary

Data relevant to the research question, such as the target subject and method of surveillance, setting and context, and type of evidence were extracted. Results were summarized narratively to provide an overview of trends in the included literature.

The quality of included studies was not assessed as this scoping review reports on trends in studies and does not report study findings.

Findings

Summary of Evidence

A total of 244 articles, including 82 evidence syntheses and 162 single studies, describing surveillance methods are included in this report. In addition, 109 articles discussed the implications of changes to public health surveillance programs from ethical, security, legal and equity perspectives.

Figure 1 below illustrates the number of included articles that report on the various surveillance methods used for the target surveillance subjects, listed by public health topic area. Please note that the numbers for each surveillance methods may not reflect the total number of resources in this report, as some syntheses discuss more than one surveillance method.
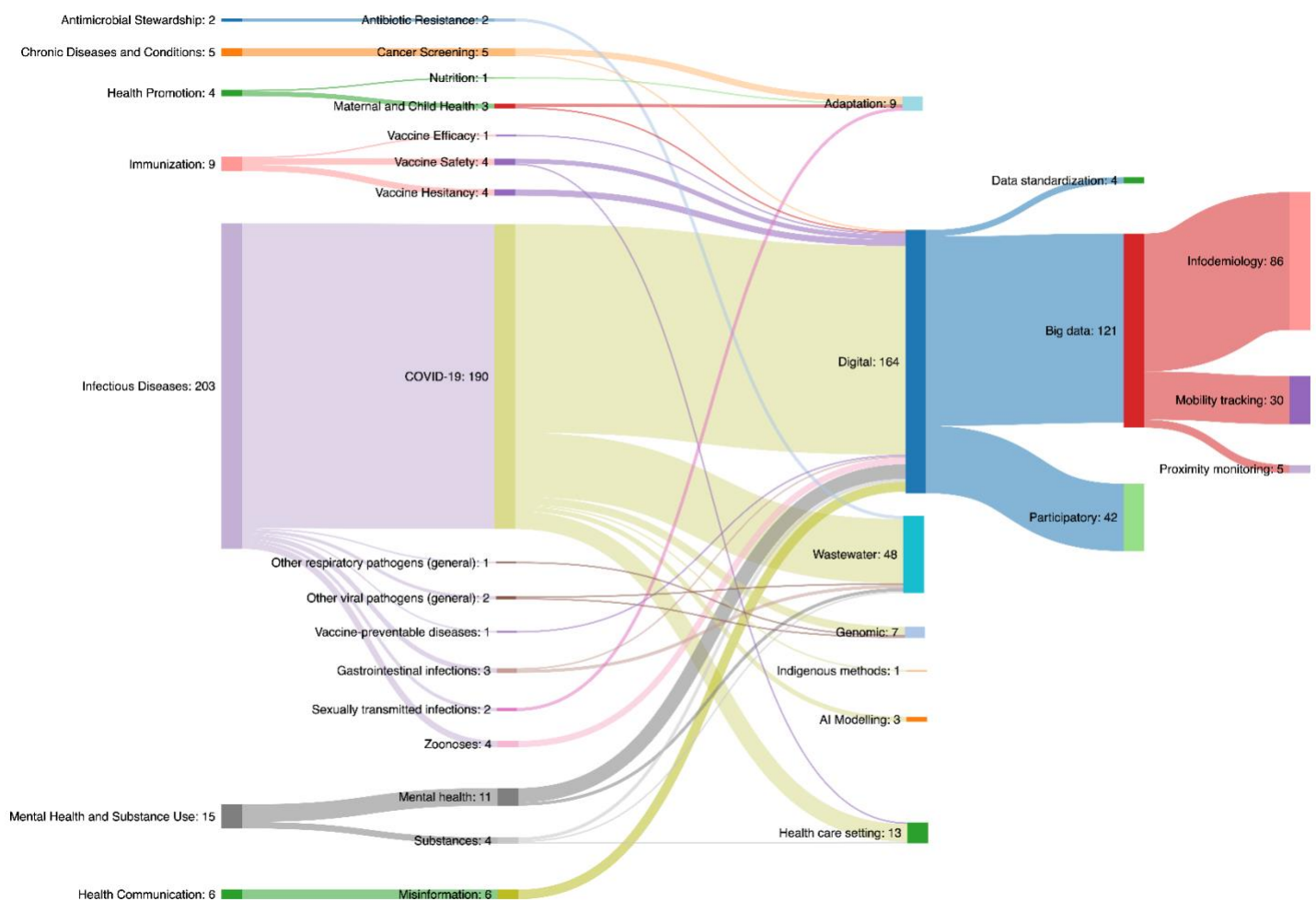

Figure 1: Sankey diagram outlining the various surveillance methods used for the target surveillance subjects.

Surveillance Methods

This document includes 82 completed syntheses and 162 single studies for a total of 244 publications describing surveillance methods included in this review. The number of studies and syntheses that report on each surveillance subject are listed in the table below, organized by public health topic area.

Subject	Number of Syntheses	Number of Single Studies
Antimicrobial Stewardship		
Antibiotic resistance	1	1
Chronic Diseases and Conditions		
Cancer screening	1	4
Environmental and Occupational Health		
None	0	0
Health Equity		
None	0	0
Health Promotion		
Nutrition	1	0
Maternal and Child Health	0	3
Immunization		
Vaccine Efficacy	0	1
Vaccine Safety	1	3
Vaccine Hesitancy	0	4
Infectious Diseases		
COVID-19	69	121
Other respiratory pathogens (general)	1	0
Other viral pathogens (general)	1	1
Vaccine-preventable diseases	0	1
Gastrointestinal infections	1	2
Sexually transmitted infections	1	1
Zoonoses	1	3
Mental Health and Substance Use		
Mental Health	2	9
Substance Use	1	3
Health Communication		
Misinformation	1	5
Total	**82**	**162**

Lists of articles organized by public health topic and surveillance method included in Supplemental Resource 1.

The number of articles describing various surveillance methods are summarized in the following table. AI emerged as a prominent approach used to augment several surveillance methods, as indicated in the table.

Method				Number of Included Articles			Number using AI		
Adaptation to existing practice				9			0		
AI-driven modelling				3			3		
Digital Surveillance				163			34		
	Data standardization				4			0	
	Participatory				39			4	
	Big data				131			32	
		Mobility tracking				36			12
		Proximity monitoring				5			0
		Infodemiology				86			22
Health care setting				11			0		
Indigenous methods				1			0		
Wastewater				48			1		

Note: The number of articles in this table total greater than the number of resources included in this review, as some syntheses included more than one method.

Ethical Implications

A total of 109 articles discussing the implications of changes to public health surveillance programs from ethical, security, legal and equity perspectives were found. These articles are summarized in the following table.

Method	Number of Articles	Article Focus			
		Ethics	Security	Legality	Equity
Wastewater	4	3	0	2	2
Digital Surveillance	105	81	29	29	21

Detailed lists of articles included this review are included in Supplemental Resource 2.

There is considerable literature overall that has emerged related to advances in surveillance during COVID-19. Some areas have seen much more literature (e.g., wastewater epidemiology), while others remain sparse (e.g., health equity for racialized populations). Possible next steps include conducting systematic reviews in those areas for which multiple studies have been identified. In other areas with sparse literature, more research is needed to advance surveillance in the post-pandemic era.

References

Arksey H, O'Malley L. Scoping studies: towards a methodological framework. *International Journal of Social Research Methodology: Theory and Practice.* 2005;8(1):19–32. DOI: 10.1080/1364557032000119616.

Appendix 1: Definitions

The following terms are defined as they are applied in this scoping review.

Methods

Digital surveillance	Use of digital technology, such as mobile phone location data, social media posts, search engine inputs or online databases, to collect and analyze data to monitor populations.
Big data	Large sets of data such as global positioning data measured by mobile phones, social media posts, search engine inputs and online survey or app data.
Infodemiology	Monitoring of trends in user-contributed health-related internet content through analysis of social media posts, search engine inputs and news media.
Internet of Things (IoT)	Devices that contain technologies, such as sensors, processors, and software, to exchange data with other devices and systems through the Internet or other networks, such as local area networks and communications networks.
Artificial Intelligence (AI)	Intelligence demonstrated by machine to take information from its environment to maximize its chances of achieving its goals

Types of Evidence

Literature review	Non-systematic summary of evidence.
Critical review	Non-systematic summary of evidence with a clear opinion or bias.
Editorial	Short article stating an opinion.
Newspaper editorial	Short article stating an opinion, featured on a news or blog site.