Public Health Surveillance in Canada: Future Directions

Early Warning Systems for Emerging and Re-Emerging Diseases Workshop, Fields Institute for Research in Mathematical Sciences, Toronto, Canada

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Overview

- Part 1: Looking back at 20 years of surveillance

- Part 2: The present: Detect, Understand & Act

- Part 3: Envisioning the future of public health surveillance in Canada

- Part 4: Working across boundaries: Integrated One Health surveillance

- Part 5: Looking beyond our borders: Cultivating global sources of data

Part 1: Looking back at 20 years of surveillance

Transformation of public health surveillance in the last 20 years

Rapid pace of innovation, evolution in technology, and increase in public awareness have changed the nature of public health surveillance:

- Public expectation for transparency and access to information
- Increased demand for data from scientists, clinicians, policy makers and media
- Recognition of the importance of health equity and disaggregated data
- Abundance of health data (adoption of electronic medical records, connected systems, wearable devices)
- Advanced analytics (big data, AI, simulation, predictive modelling)
- Data liberation (data sharing, data linkage across sectors & beyond healthcare)

Then and now: surveillance communication

- Public use of technology and expectations for receiving health information have evolved rapidly
- Shift in government policy towards open government, a streamlined web presence, and regulations to improve accessibility and web interoperability
- Surveillance skillset is evolving to include competencies to engage a breadth of stakeholders (storytelling, health literacy)

2000s | **2020s**

Technocratic

- Dense technical reports for a technical audience
- Annual reporting cycle, long release times
- Minimal and basic information for the public

Democratic

- Storytelling, social media, interactive tools
- Open government, streamlined web presence
- Media and the public expect real-time information in accessible format

Then and now: surveillance communication

2000s → 2020s

It's Your Health (Health Canada / Santé Canada)

This article was produced in collaboration with the Public Health Agency of Canada.

STROKE

The Issue

Stroke is one of the leading causes of death in Canada. The risk of stroke increases with age, but in many cases lifestyle changes can decrease your chances of having a stroke.

Background

Most strokes occur when a blood clot blocks a blood vessel in the brain, interrupting the supply of blood and oxygen to the brain cells in the area. The breaking of a blood vessel in the brain and the resulting bleeding can also cause a stroke. In both types of stroke, brain cells may die, causing the parts of the body they control to stop functioning.

Between 40,000 and 50,000 Canadians are hospitalized each year for strokes, and about 15,000 of these are fatal. In 2003, about 272,000 Canadians 12 years of age and older were living with the effects of having a stroke.

Although strokes can occur in children, the risk of stroke increases with age. After age 55 your risk of stroke doubles every 10 years. Males have a slightly higher prevalence of living with the effects of having a stroke than females in all age groups, in total 51% males, 49% females. However, 59% of stroke deaths occur in women, likely because women live longer, and men are more likely to die from other causes.

A stroke survivor has a 20% chance of having another stroke within two years.

• sudden severe and unusual headache; and

• unsteadiness or a sudden fall, especially with any of the above signs.

If you experience any of these signs, call 911 or your local emergency number immediately! There is now medication that, if administered in the early stages of a stroke, can help minimize the effects.

Health Risks of Stroke

Although the risk of stroke increases with age, the risk also rises if you:

• smoke;

• have high blood pressure;

• have hardening of the arteries;

• have heart disease;

• have diabetes; or

• have a family history of heart problems.

Health Effects of Stroke

Strokes affect people in different ways, depending on the type of stroke, the area of the brain which is affected and the size of the damaged area.

The common effects of a stroke include:

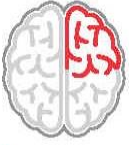• paralysis or weakness on one side of the body;

STROKE in CANADA

WHO is AFFECTED?

ABOUT **878,500** CANADIAN ADULTS AGED 20+ HAVE EXPERIENCED A STROKE 2017–2018

OR 438,700 / 439,800

1/4 OF CANADIANS LIVING WITH STROKE ARE UNDER AGE 65

STROKE RISK RISES RAPIDLY AFTER AGE 55

WHAT are the RISKS?

HIGH BLOOD PRESSURE IS THE **STRONGEST RISK FACTOR** FOR A STROKE.

OTHER RISK FACTORS include smoking, obesity, diabetes, high blood cholesterol, atrial fibrillation (afib), a sedentary lifestyle and diet low in fruits and vegetables.

HOW to REDUCE THE RISKS?

- KEEP BLOOD PRESSURE UNDER CONTROL
- BE PHYSICALLY ACTIVE
- EAT A HEALTHY DIET
- QUIT SMOKING

Then and now: health equity

- Recognition of the impact of the social determinants of health
  - WHO's Rio Political Declaration on the Social Determinants of Health (2011)
  - United Nations 2030 Agenda for Sustainable Development (2015)
- Truth and Reconciliation Commission exposes the importance of respect for Indigenous data sovereignty
- Increased engagement with priority populations and health equity data

2000s ← → **2020s**

Equity is a consideration

- SARS response missing equity data & analysis
- Communities sometimes invited to provide feedback on reports
- Limited monitoring of health equity in surveillance
- Limited understanding of the impacts of SDH on diseases

Equity is integral

- **Pan-Canadian Health Inequalities Reporting Initiative** provides ongoing measurement, monitoring, and reporting of health inequalities in Canada.
- **COVID-19 Surveillance systems at local levels** collect equity data elements during the pandemic and demonstrate inequity in COVID-19 related outcomes

Then and now: scope of public health surveillance

- Scope broadened from infectious diseases to include injuries, chronic diseases, mental health, animal health, and occupational and environmental health

- Recognition of the limitations of case-based surveillance, and the importance of complementary information to understand health trends

- Promotion of the One Health approach (e.g., *'Contributing to One World, One Health'* (2007) International Ministerial Conference on Avian and Pandemic Influenza in New Delhi)

2000s ───────────────────────────────── **2020s** ⟶

Narrow focus on infectious disease

- Public health surveillance focused on traditional, case-based surveillance systems for infectious disease

Broader focus on health threats

- Increased surveillance on issues outside of infectious disease, e.g., Pan-Canadian surveillance of opioid overdose, positive mental health surveillance indicator framework
- **Introduction of complementary data**, such as behavioral and seroprevalence surveys along with case-based surveillance for HIV surveillance
- **Surveillance through a One-Health lens,** integrating surveillance of people, animals, plants and their shared environment

Then and now: integrated disease surveillance

- Integrated disease surveillance (IDS) and response established by the WHO regional office in Africa in 1997 to ensure comprehensive public health information available for rapid response.

- IDS since adapted primarily in low-and-middle-income countries, and increasingly in high-income countries.

- COVID-19 pandemic further established the importance of integrating multiple sources of information (case-based, laboratory, hospitalization, vaccination, etc.) from different sources

2000s   **2020s**

Siloed and disconnected systems

- Most of Canada's surveillance systems were designed to capture single health events using one data source
- Varying infrastructure and data standards across surveillance systems

Towards integrated systems
PHAC leads and/or partners on several integrated disease systems, including:
- Canadian Integrated Program for Antimicrobial Resistance (CARS)
- Antimicrobial resistance network (AMRNet)
- FoodNet Canada
- COVID-19 data trends
- Canadian Chronic Disease Surveillance System (CCDSS)

Example of integrated disease surveillance:
Canadian Integrated Program for Antimicrobial Resistance
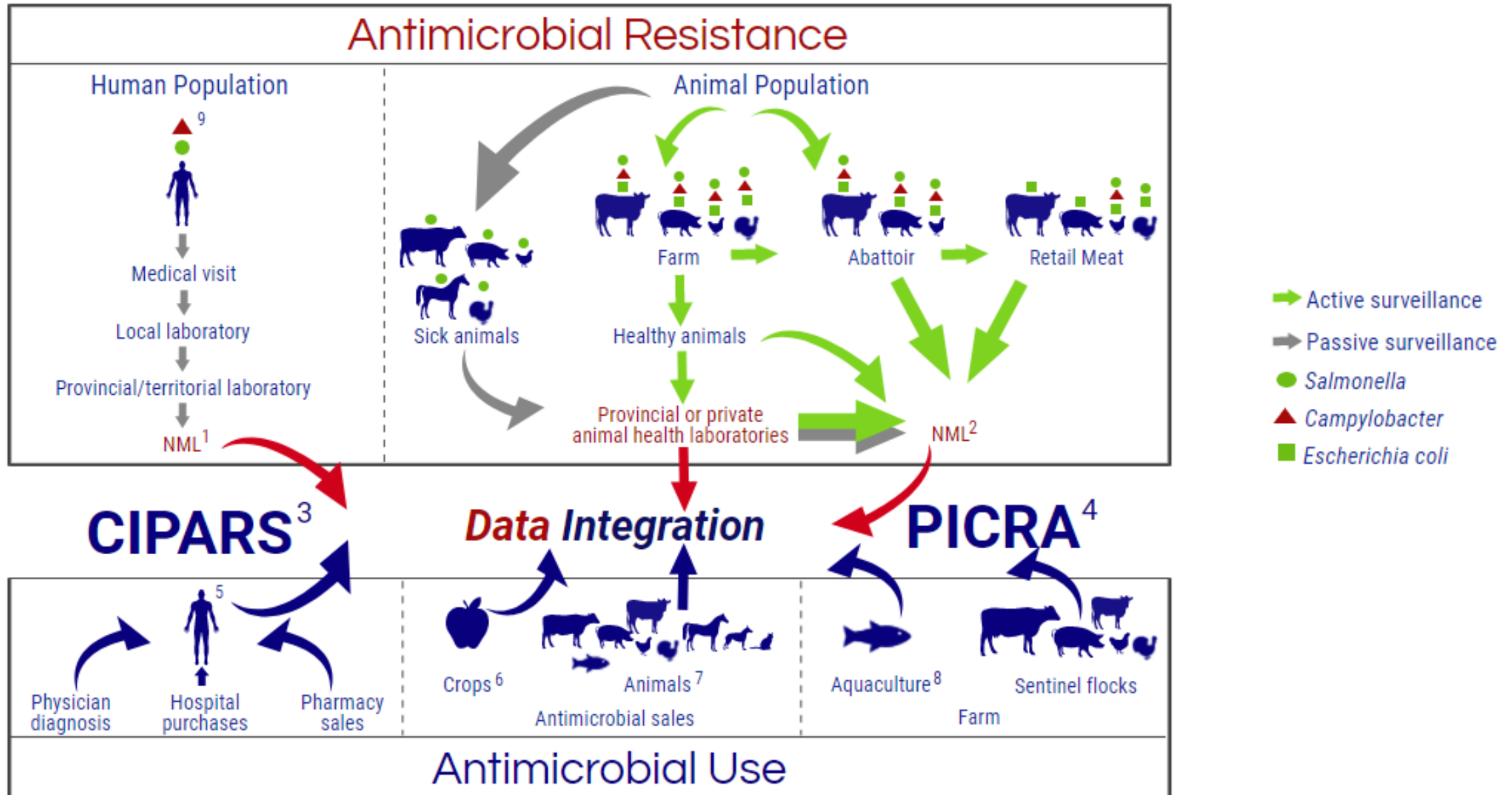
Then and now: novel data and methods

- Substantial increases in the amount and types of data available, as well as the technologies to manage large volumes of data are giving rise to "big data" and other opportunities for innovation.

2000s

Transition to electronic health records

- Data was siloed, difficult to access, link & share
- Digital health administrative data was incomplete and unreliable
- Social media, mobile phone and genomic data were not widely used
- Novel innovations were just emerging – e.g., Public Health Genomics, the Canadian Network for Public Health Intelligence

2020s

Health data abundance

- COVID-19 expedited adoption of new data & methods
- COVID-19 Vaccine Web Monitoring Surveillance System uses social media & search queries to track misinformation, vaccine hesitancy, and to identify symptoms/adverse events
- Wastewater surveillance provides situational awareness and early warning signals
- GISAID repository for genomic information

Then and now: global health surveillance

- Several pandemics over the last two decades, including SARS, Ebola and COVID-19 heightened the recognition that the threat of disease extends beyond borders and the importance of global intelligence to detect and respond to threats early.

2000s ← → **2020s**

Global health surveillance is in its infancy

- Global Public Health Intelligence Network (GPHIN) was established the late 1990s and considered an important component of national & global pandemic preparedness, especially after SARS outbreak
- Other global health surveillance systems (e.g., International Circumpolar Surveillance for Infectious Diseases) are just established

Global health surveillance is critical to health security

- **GPHIN** is recognized in Canada and internationally as an essential component of the detection and reporting of diseases and other health threats
  - Provides ~20% of WHO's Epidemiological Intelligence from Open Source (EIOS) input
  - Monitors news media in nine different languages
- Negotiations of draft pandemic instrument highlight the need for international collaboration and information sharing

Challenges that lie ahead

Surveillance has evolved over the last two decades, but challenges remain:

- Surveillance systems remain largely siloed
- Equity stratifiers are not yet collected in many surveillance systems
- Health equity data is not always analyzed or used effectively, and may lack input from priority populations
- Ensure Indigenous data sovereignty is implemented and upheld at all levels of government
- Reliability and validity of novel data sources is still being assessed (e.g., social media data, wearable health trackers, mobile phone data)
- Health literacy and trust among the public is needed to advance novel data & methods (e.g., data linkage beyond health records)
- Need to balance open data and transparency with the potential for misuse and misinterpretation of publicly available data

Part 2: The present

What are we doing now? Detect, Understand, Act

Modernizing public health surveillance

Vision: To enable sustainable surveillance and risk assessment capabilities across PHAC beyond 2025

Deliver on commitments to strengthen core surveillance programs

- Collectively track progress on objectives, and manage risk in a more integrated manner through coordinated and collaborative governance

Improve performance

- Enhance data capacities and capabilities by building a cohesive data infrastructure to support interoperability, and empowering surveillance teams and systems with modern tools
- Set and move towards higher performance standards Agency-wide

Build the foundation toward an ambitious future-state for surveillance

- Develop a vision for the future state of public health surveillance across Canada through engagement with internal partners and external stakeholders
- Build on operational evidence and our performance story to inform strategic future investments that will support and sustain surveillance in the longer-term

Investing in public health

2022 BUDGET

Budget 2022 provided significant new investments **strengthen Canada's ability to detect and respond to public health events and emergencies:**

- Stabilizing monitoring and reporting of COVID-19 response
- Building foundations to address non-COVID-19 monitoring and reporting needs
- Carrying forward lessons learned to ensure Canada's public health system is prepared for the future, and
- Enabling and positioning Canada to be an active leader in the global identification, assessment, and management of public health risks

Enhancing our ability to Detect and Understand public health risks

DETECT public health threats

- Governance of shared health data
- Revitalizing the Global Public Health Intelligence Network
- Surveillance of COVID-19 and respiratory diseases
- Genomic sequencing and wastewater surveillance
- Vaccine surveillance

UNDERSTAND the risks

- Establish Agency-wide integrated risk assessment
- Strengthen program risk assessment
- Monitor wider health impacts of COVID-19 pandemic
- Enhanced public interface

Improving our core surveillance capabilities

Minimum standards

Achievable and continuously improved standards that will be expected of all surveillance systems:

- **Timeliness** – surveillance data is released to users for decision-making in a timely manner
- **Interoperability** – surveillance systems and health data interoperability facilitates access and sharing for decision-making
- **Surveillance data equity** – data to include age, sex, gender, income and other related variables to improve our ability to conduct more in-depth analysis using a health equity lens
- **Building trust** – information on why and how surveillance activities are conducted is shared with the public

Enhancing our ability to <u>Detect</u>

Pan-Canadian Wastewater Surveillance Network

- Monitoring new public health threats and chronic conditions by harnessing power of advanced tools and techniques (e.g., metagenomics) that were developed to monitor spread of COVID-19

- Builds on partnerships developed during COVID-19, and includes:
  - ➢ municipal, provincial and territorial governments
  - ➢ federal departments
  - ➢ academia
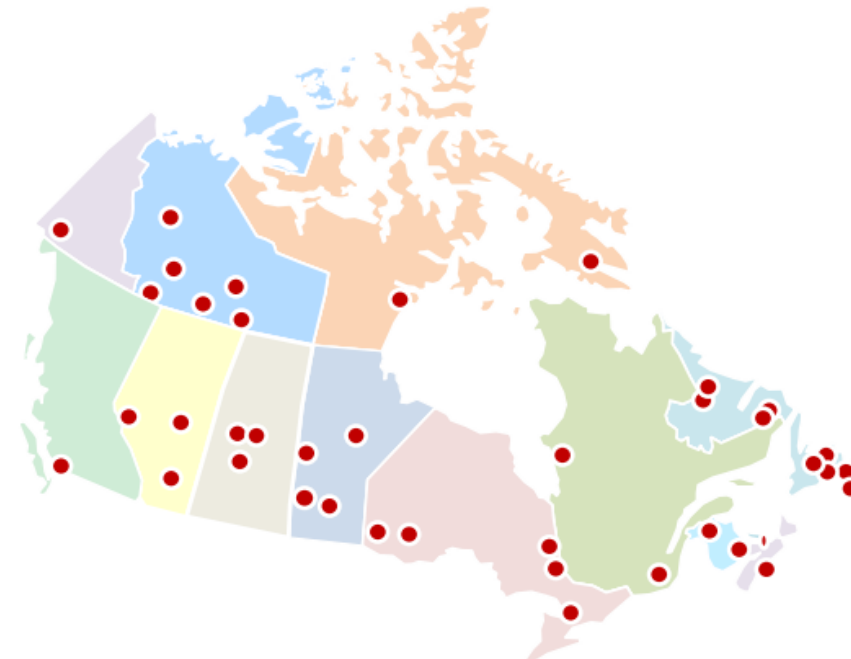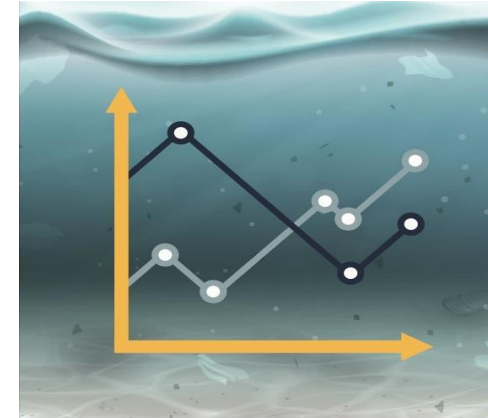
Enhancing our ability to <u>Understand</u>

Centre for Integrated Risk Assessment

Launched in November 2021 in response to recommendations from the Office of the Auditor General of Canada Report[1] and the Global Public Health Intelligence Network (GPHIN) Review Panel

THREAT

Signal detected and validated as potential public health threat

Threat Assessment

Threat is assessed by programs and Scientific Committee for Coordinated Threat Assessment (SCCTA)

Rapid Risk Assessment

Assessment of risk conducted rapidly by CIRA and subject matter experts (SMEs) to support early response.

Conducted when:
- Risk questions have been identified, requiring estimation of likelihood and impact

Risk Assessment (RA)

Full-scale risk assessments – iterative, intensive, and comprehensively analyzed using multi-method approaches. Conducted by CIRA, SMEs and RA specialists to inform decision making. RAs are built on work from a RRA.

Completed when:
- Risk questions and/or pathways are complex and multi-faceted
- Assessment requires collaboration & expertise from multiple areas

Short term

- < 24 hours
- Narrative/Qualitative
- Weekly threat report

- < 2-3 weeks
- Qualitative
- RRA Report

Medium to long-term

- > 3 months
- Semi-quantitative or Quantitative or Qualitative
- RA Report

Part 3: The future

Envisioning the future of public health surveillance in Canada
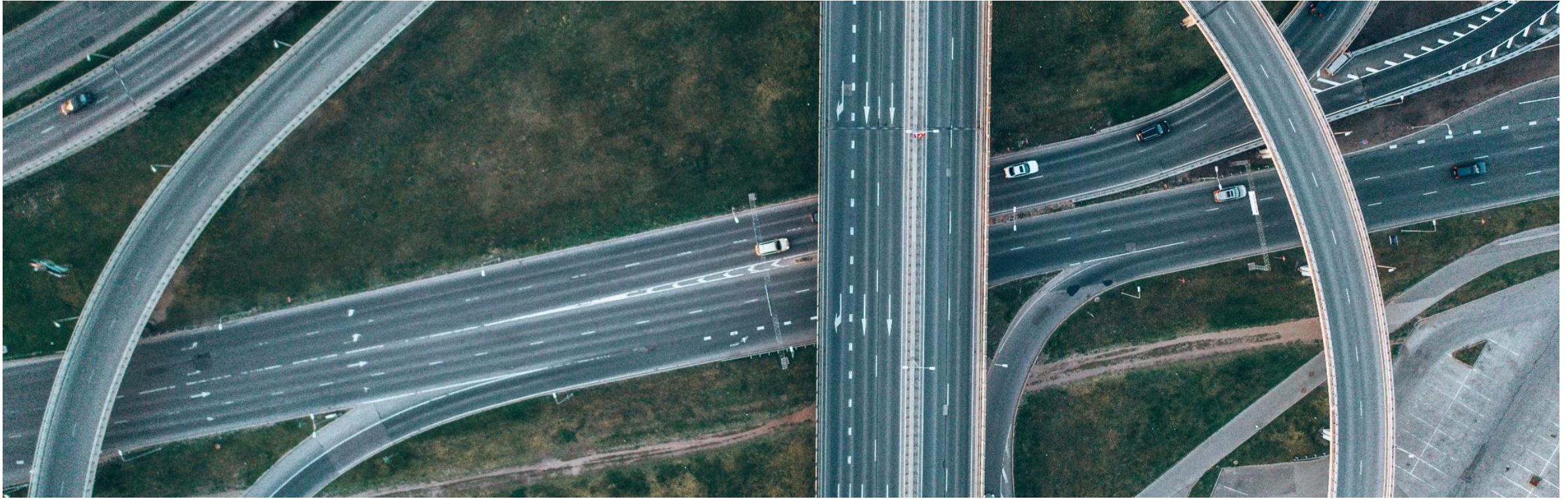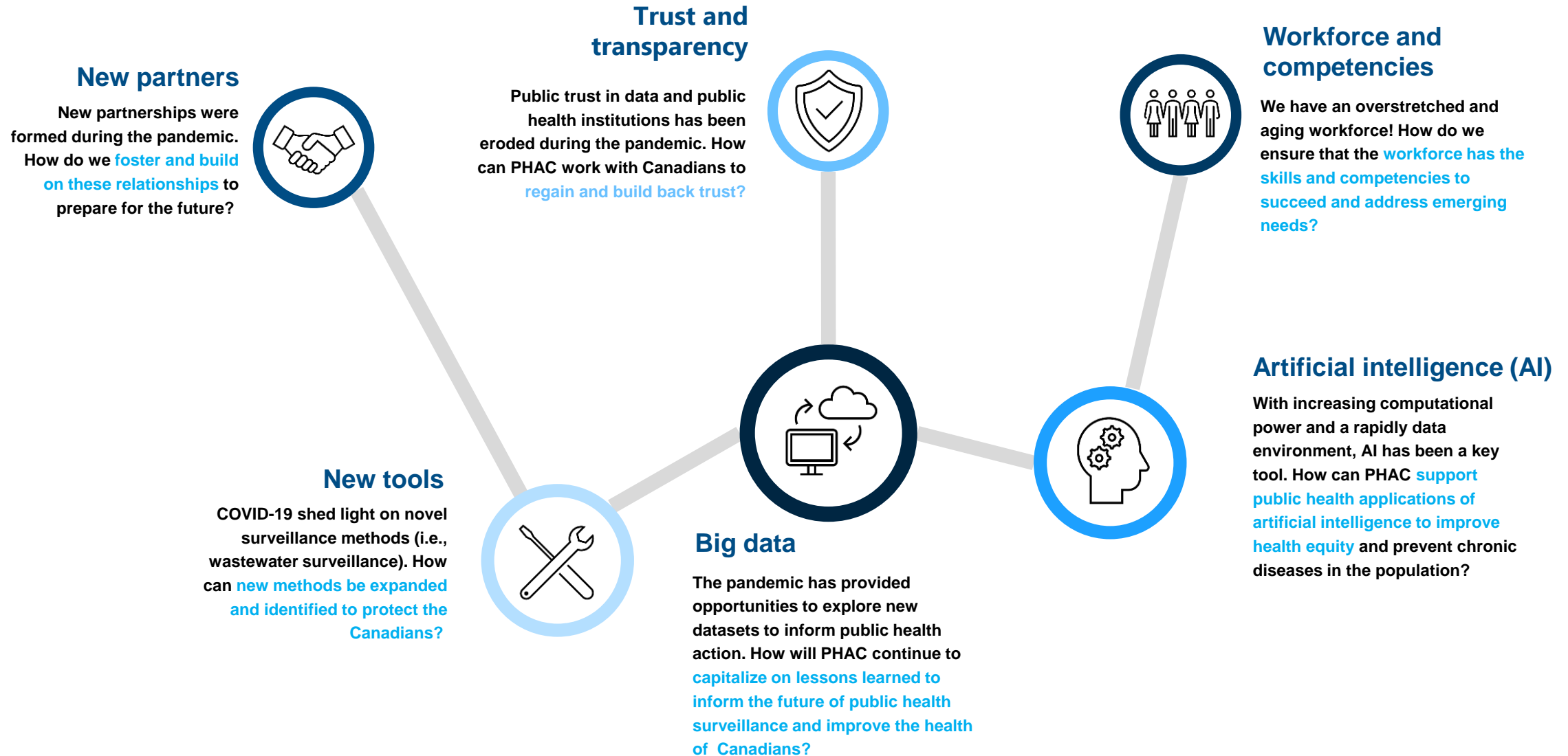
Where are we at?

Image Source: Photo by wirestock / Freepik

- The COVID-19 pandemic exposed the critical importance of an ambitious shared vision for strengthening public health surveillance.

- The public health surveillance community rallied around a common goal and shared urgency to drive innovation and improve existing systems and processes.

Opportunities and challenges

New partners

New partnerships were formed during the pandemic. How do we foster and build on these relationships to prepare for the future?

Trust and transparency

Public trust in data and public health institutions has been eroded during the pandemic. How can PHAC work with Canadians to regain and build back trust?

Workforce and competencies

We have an overstretched and aging workforce! How do we ensure that the workforce has the skills and competencies to succeed and address emerging needs?

Artificial intelligence (AI)

With increasing computational power and a rapidly data environment, AI has been a key tool. How can PHAC support public health applications of artificial intelligence to improve health equity and prevent chronic diseases in the population?

New tools

COVID-19 shed light on novel surveillance methods (i.e., wastewater surveillance). How can new methods be expanded and identified to protect the Canadians?

Big data

The pandemic has provided opportunities to explore new datasets to inform public health action. How will PHAC continue to capitalize on lessons learned to inform the future of public health surveillance and improve the health of Canadians?

Looking Ahead

Canada needs a vision that will challenge and inspire the surveillance community. PHAC will use a collaborative and engaging process to help define an aspirational vision for the future of public health surveillance.

Approach

Developing a **vision for the future of public health surveillance in Canada,** that will create opportunities to enhance the ability of Canada's surveillance programs to **identify and respond to threats and support evidence-based policy and decision-making**.

Canadians and international partners will be invited to co-create the future of public health surveillance in Canada.

Plan **Engage** **Design** **Inspire & Innovate**
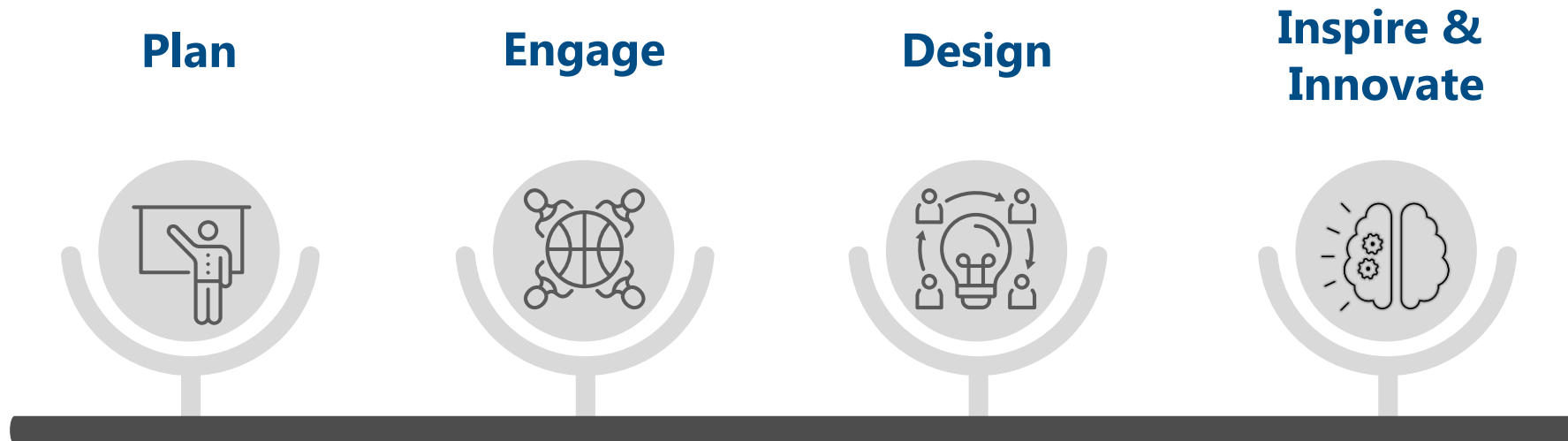
Breaking down siloes into the future

Part of our vision for the future of surveillance and pandemic preparedness means:

- **Working across boundaries** with a focus on i**ntegrated One Health surveillance**

- Looking and working **beyond our borders** and **cultivating global sources of data**

Part 4: Working across boundaries
Integrated One Health surveillance

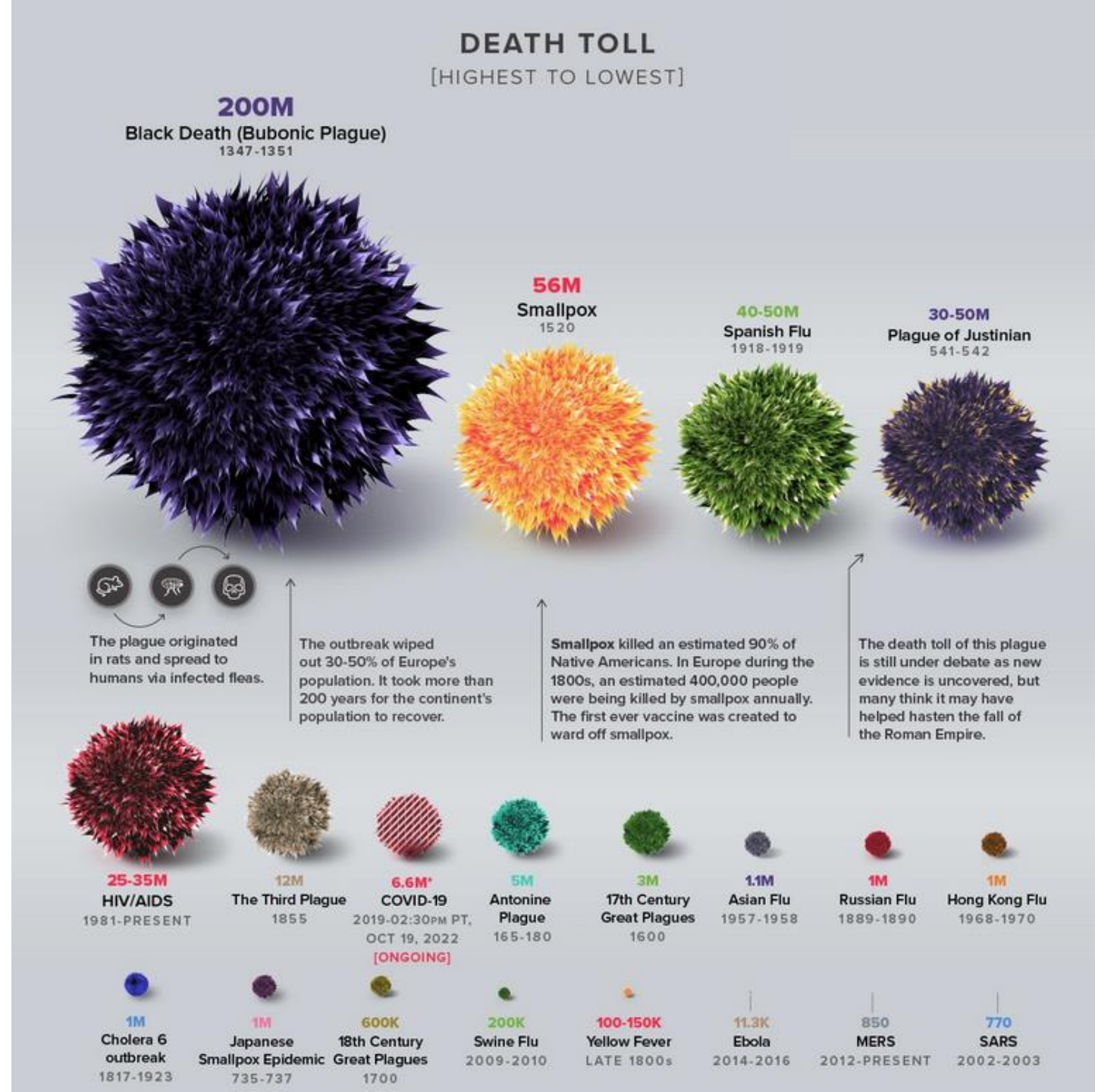# One Health – A necessary foundation for pandemic prevention

- **One Health** is an integrated, unifying approach that aims to sustainably **balance and optimize the health of humans, animals, plants and ecosystems,** recognizing that they are all **closely linked and interdependent**
- The approach **mobilizes multiple sectors, disciplines and communities** at varying levels of society
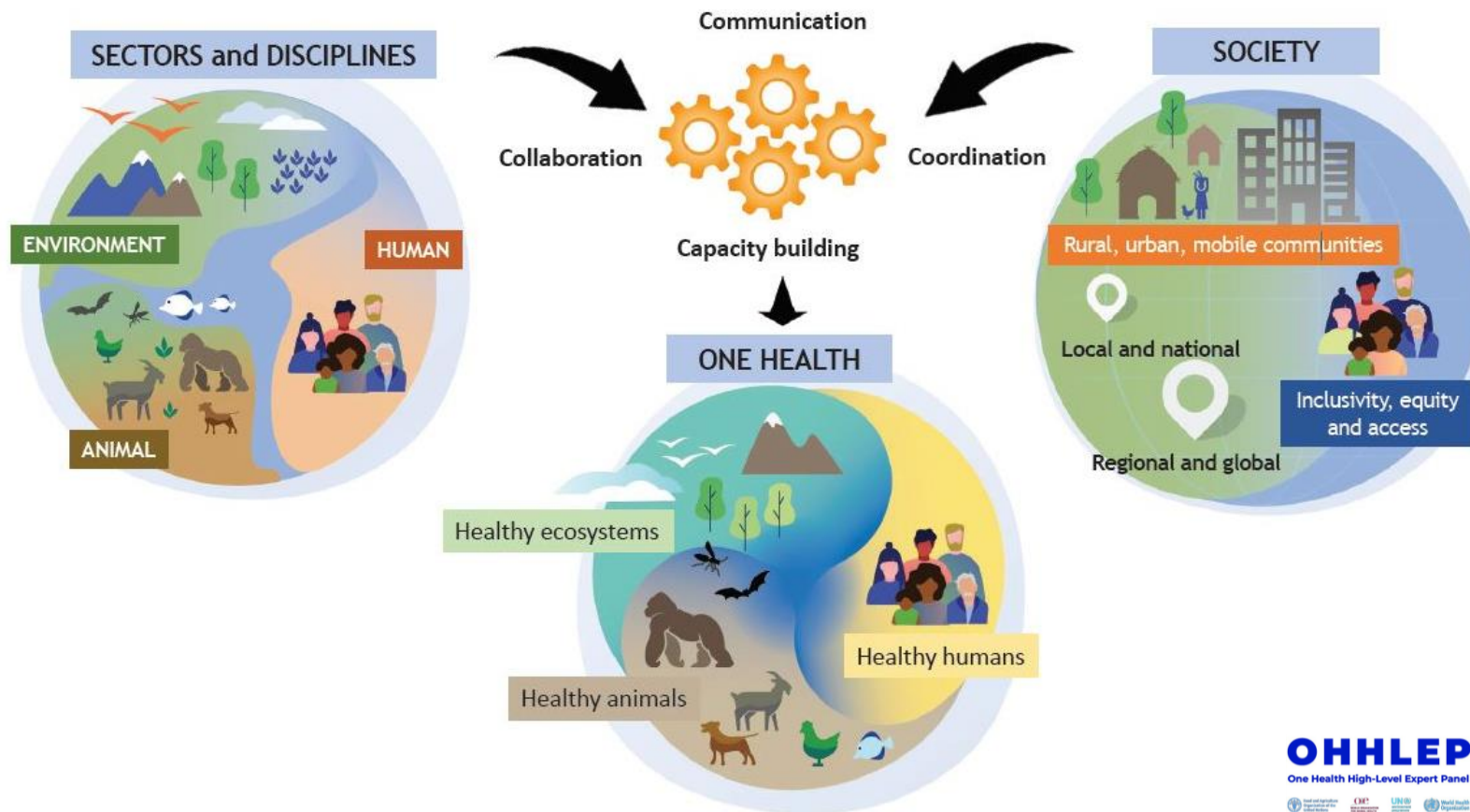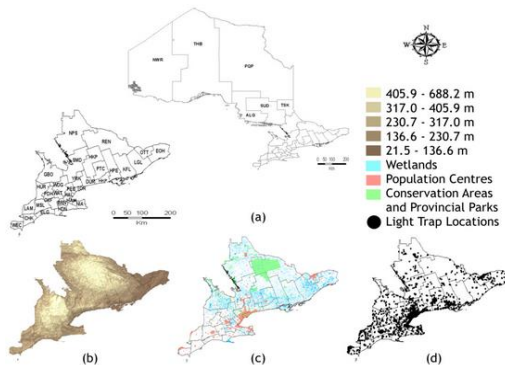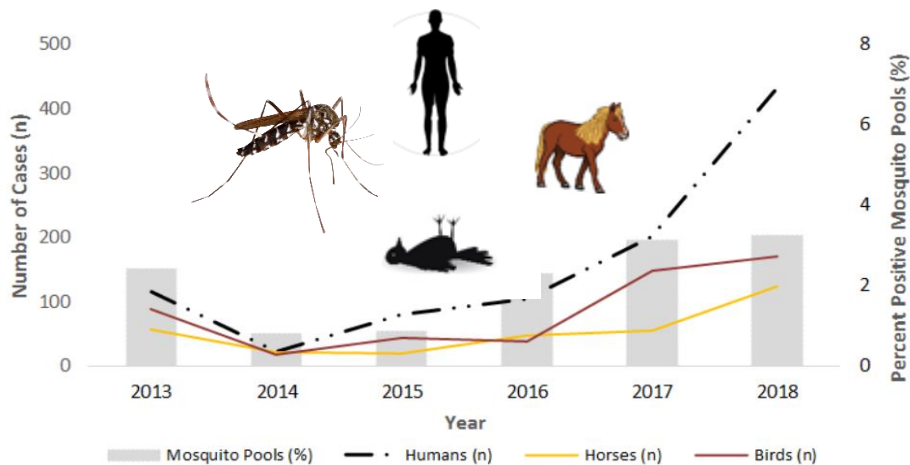
Cautionary tales: animal-origin pathogens

- **6 of 7** WHO declarations of Public Health Emergency of International Concern since 2009 have been pathogens of non-human animal origin

- **75%** of recently emerging infectious diseases affecting humans are of animal origin

- **> 60%** of emerging infectious disease events are caused by non-human animal pathogens

Given the impact of diseases of animal origin on human populations, the future of surveillance is through a One Health lens

DEATH TOLL
[HIGHEST TO LOWEST]

200M
Black Death (Bubonic Plague)
1347-1351

56M
Smallpox
1520

40-50M
Spanish Flu
1918-1919

30-50M
Plague of Justinian
541-542

The plague originated in rats and spread to humans via infected fleas.

The outbreak wiped out 30-50% of Europe's population. It took more than 200 years for the continent's population to recover.

Smallpox killed an estimated 90% of Native Americans. In Europe during the 1800s, an estimated 400,000 people were being killed by smallpox annually. The first ever vaccine was created to ward off smallpox.

The death toll of this plague is still under debate as new evidence is uncovered, but many think it may have helped hasten the fall of the Roman Empire.

25-35M
HIV/AIDS
1981-PRESENT

12M
The Third Plague
1855

6.6M*
COVID-19
2019-02:30PM PT, OCT 19, 2022
[ONGOING]

5M
Antonine Plague
165-180

3M
17th Century Great Plagues
1600

1.1M
Asian Flu
1957-1958

1M
Russian Flu
1889-1890

1M
Hong Kong Flu
1968-1970

1M
Cholera 6 outbreak
1817-1923

1M
Japanese Smallpox Epidemic
735-737

600K
18th Century Great Plagues
1700

200K
Swine Flu
2009-2010

100-150K
Yellow Fever
LATE 1800s

11.3K
Ebola
2014-2016

850
MERS
2012-PRESENT

770
SARS
2002-2003

One Health in action: West Nile Virus surveillance

Giordano et al. Geospatial Analysis and Seasonal Distribution of West Nile Virus Vectors (Diptera: Culicidae) in Southern Ontario, Canada. Int. J. Environ. Res. Public Health 2018, 15, 614. https://doi.org/10.3390/ijerph15040614

Vector-borne zoonotic disease control is best addressed with a One Health approach – the One Health system for WNV is responsive to inherent complexities of the pathogen and its transmission dynamics

- WNV surveillance in Canada uses a **highly integrated and collaborative One Health approach**
  - Partners in human, animal, and environmental health and across levels of government
  - integrates data from humans, sentinel animals (e.g., horses, birds), and mosquitoes
- PHAC works with federal/provincial/territorial partners, supporting national surveillance through:
  - Regular surveillance reports on indicators to inform prevention measures and identify high risk hotspots
  - Coordinating information sharing on WNV & other mosquito-borne diseases
  - Public communications advising of WNV risks during mosquito season

One Health: investing in global health security
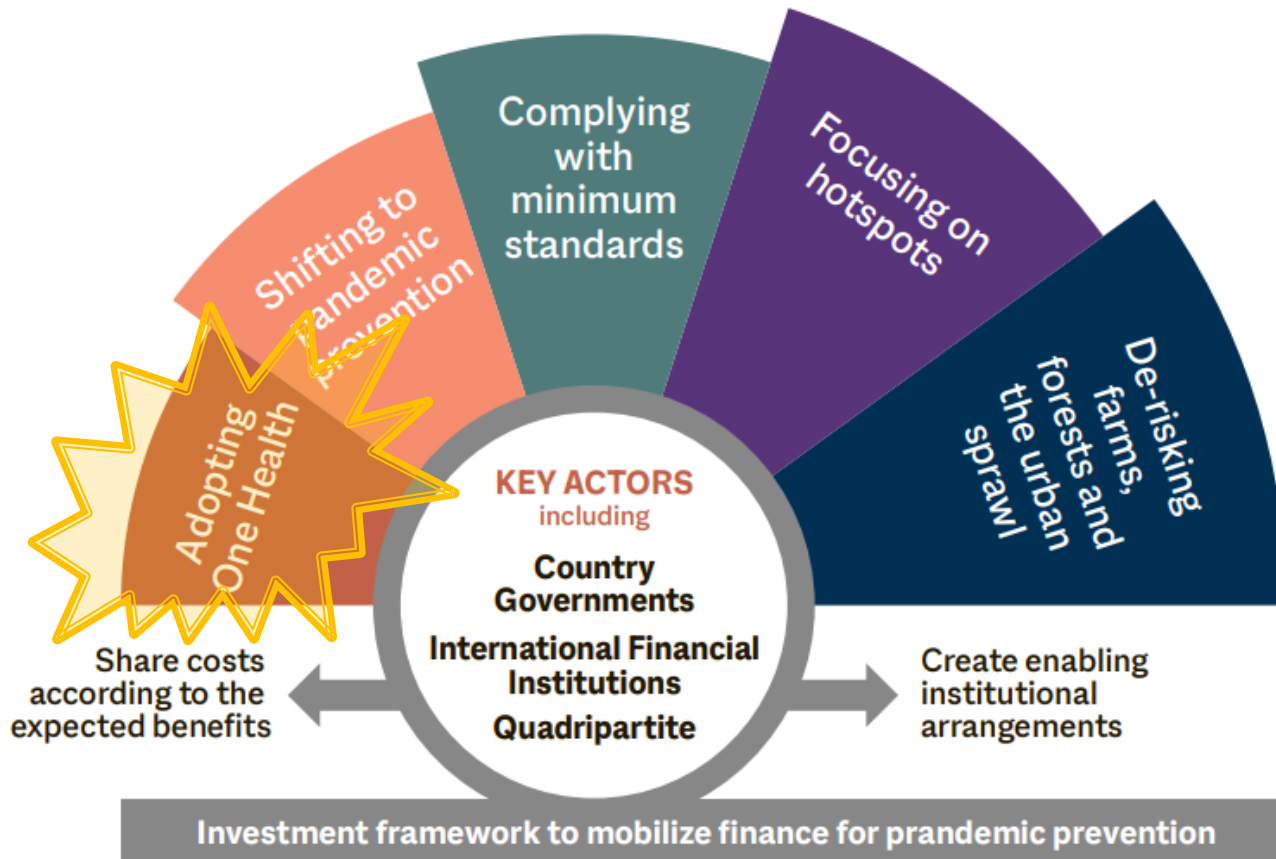
Effectively addressing the challenges posed by pandemics requires a departure from the old cycle of panic and neglect

Opportunity knocks:
- **Timing:** Now – on the heels of the COVID-19 pandemic, this is the opportune time to transition to One Health approaches
- **Costs:** Lower – economists (and the World Bank) advise costs are relatively modest for prevention vs. crisis response
- **Co-benefits:** Many – for sustainable and human development, resilience of health systems, the environment and many more

One Health: calls to action

From the literature:

> "When diverse disciplines and their resources are brought together to address a complex challenge, they can answer questions and gain insights that no single discipline could generate in isolation." Aguirre et al. (2021)

From Canadian recommendations:

> "Strengthening surveillance, risk assessment, research, and innovation can have immediate positive impacts on the cultivation of One Health intelligence, which will enhance Canada's capability for early detection, understanding and action to address emerging human-animal environmental health threats and position Canada as a global leader in innovative One Health solutions." CIHR (2022)

From international recommendations:

> "Investing in One Health based prevention is the best way forward to break the cycle of panic and neglect—once and for all. If we fail to act now, we will be destined to become like Sisyphus, forever rolling a boulder uphill to manage the response to the next pandemics." World Bank (2022)

Global initiatives for One Health

## Quadripartite One Health Joint Plan of Action

- **Vision:** a world better able to prevent, predict, detect and respond to health threats and improve the health of humans, animals, plants and the environment while contributing to sustainable development

One Health Intelligence Scoping Study

- **Aim:** to identify opportunities for improved technical harmonization of prioritized systems to strengthen One Health intelligence
- **Key recommendation:** immediate actions should be taken to develop a Global One Health Intelligence System

## Versatile Emerging Infectious Disease Observatory

- **Vision:** virtual observatory for the generation and distribution of actionable information for evidence-based early warning, risk assessment and monitoring of infectious disease threats in the One Health domain
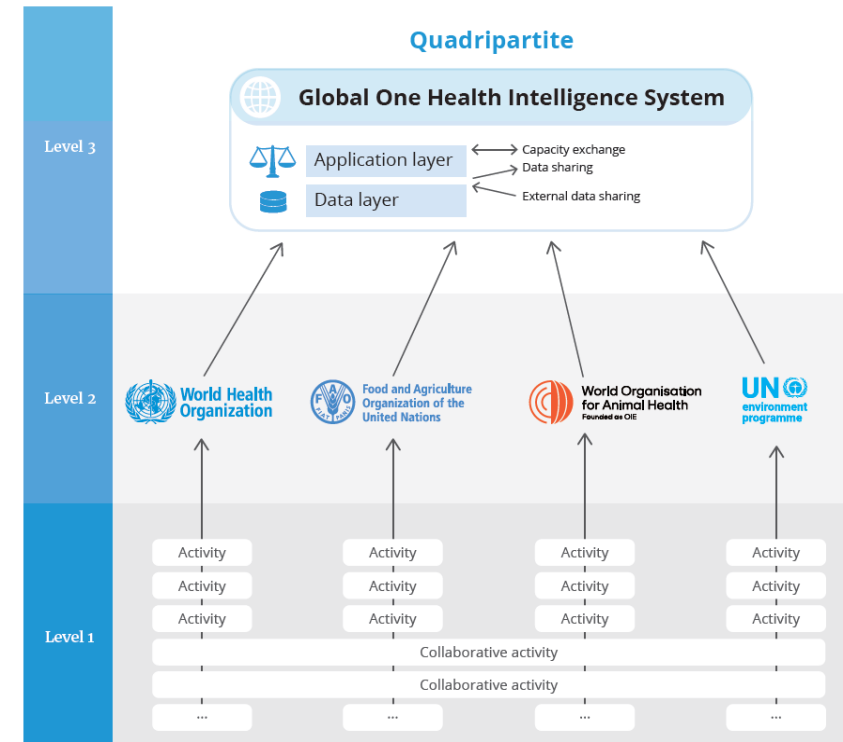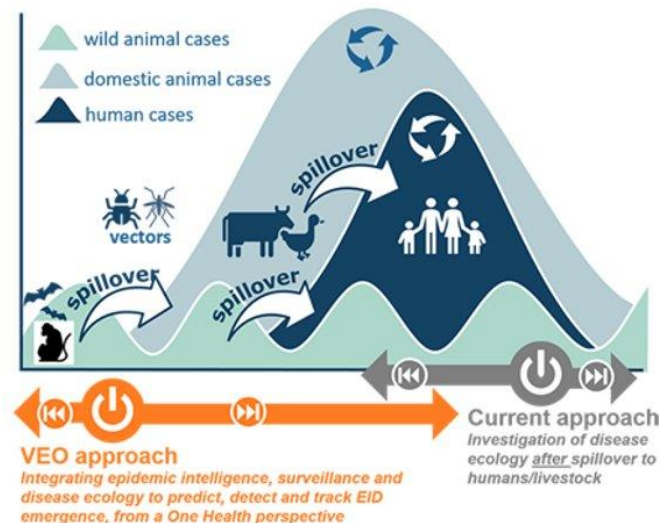
Part 5: Looking beyond our borders
Cultivating global sources of data

The context of Canada and global data

Canada, 0.48%

World, 99.52%
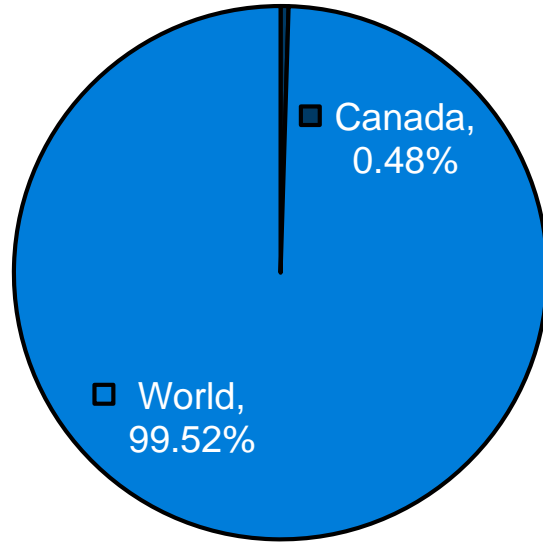
Canada's population represents **0.48%** of the world, meaning **99.52%** of public health risks begin outside of Canada

Canada is one of the most globally integrated countries in the world with **8.3 million** or **23%** immigrants

Immigrants, 23%

Total Population, 77%
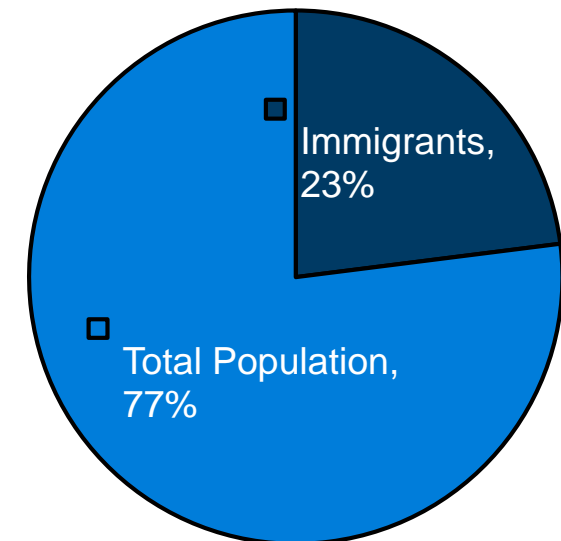
Canada must think globally when it comes to **Detecting** and **Understanding** public health threats.

So, when it must **Act**, Canada has the time to mobilize and the accurate knowledge to intervene.

Cultivating global sources of data

Canada needs to cultivate global sources of data to gain a more complete understanding of public health issues. Public health risks <u>transcend national borders</u> and are influenced by a variety of factors including global demographics, economic conditions and culture.

By collecting and analyzing data global sources, Canada will be better prepared to <u>Detect, Understand and Act</u> against public health threats.

Looking beyond our borders: PHAC's surveillance systems

The *Public Health Agency of Canada* currently manages 64 surveillance systems
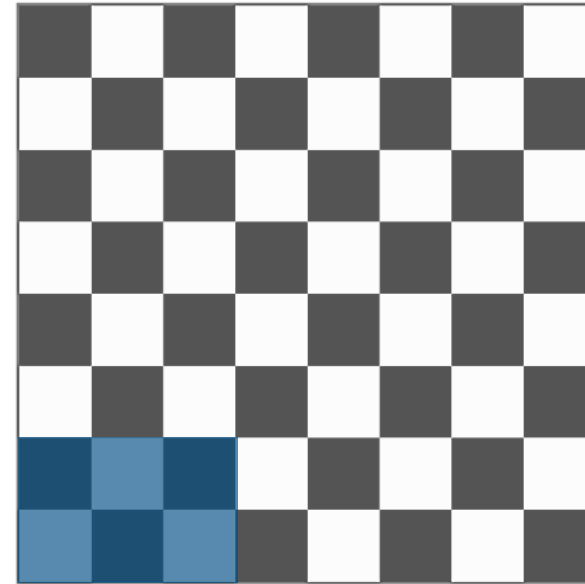
6 of which have global components:

Canadian Cancer Registry	**International Circumpolar Surveillance System**	**Integrated COVID-19 Surveillance System**
FluWatch	**COVID-19 Genomic Surveillance System**	**Global Public Health Intelligence Network**

Cultivating global sources of data: Building bridges

PHAC surveillance programs with global components

- Canadian Cancer Registry
- International Circumpolar Surveillance System
- Integrated COVID-19 Surveillance System
- FluWatch
- COVID-19 Genomic Surveillance System
- Global Public Health Intelligence Network

Leading global health data partnerships

- Global Health Data Exchange
- Human Cell Atlas
- WHO Health Data Platform
- Global Biodiversity Information Facility
- International Cancer Genome Consortium

Leading global data partnerships (non-health)

- Global Environment Monitoring System
- Global Open Data for Agriculture and Nutrition
- World Bank Open Data
- Global Human Settlement Layer
- UN Human Development Index
- Global Database of Events, Language, and Tone

Cultivating global sources of data: International pandemic instrument

In December 2021, WHO Member States agreed to launch an intergovernmental negotiating body to develop a pandemic instrument to **strengthen and coordinate national and international efforts to prevent, prepare for, and respond to pandemics.**

We are working to ensure the instrument **enhances countries' capacity to Detect, Understand, and Act on public health emergencies** by:

- promoting the transition towards modern, interoperable, and open data infrastructures
- ensuring accurate, comprehensive, and timely generation of and access to data
- encouraging knowledge sharing (within and between countries) through national and international scientific and institutional collaboration
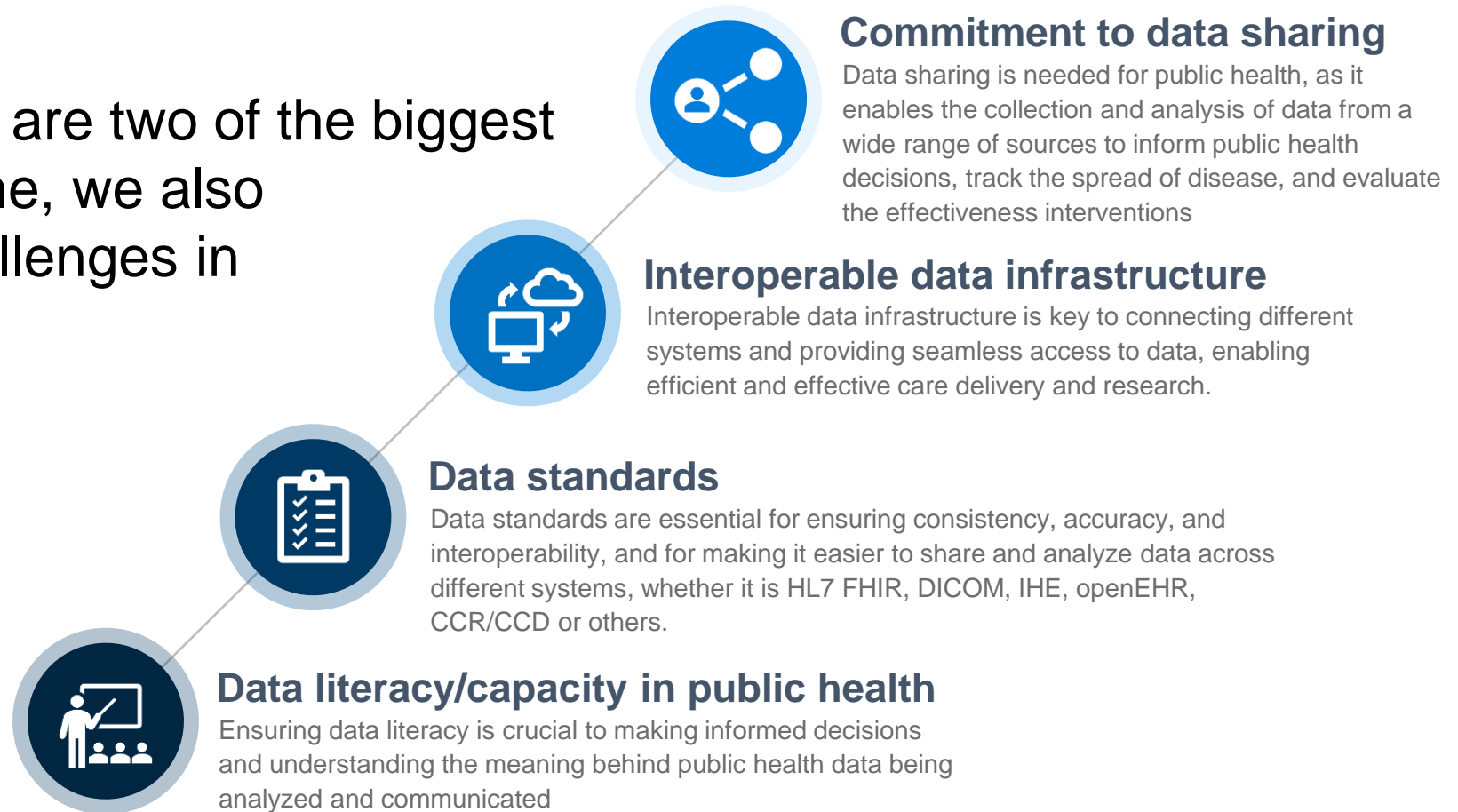
Imagine if our data was open

Now imagine all of that was made
open and linked to international data
partnerships with <u>public facing
dashboards</u> and <u>APIs</u>…

…and was secured with *quantum-resistant cryptography,
homomorphic encryption* for privacy and *ISO 8000-110
standard* for data quality

Challenges of achieving this vision

While **privacy** and **security** are two of the biggest hurdles we need to overcome, we also have more fundamental challenges in public health:

Commitment to data sharing

Data sharing is needed for public health, as it enables the collection and analysis of data from a wide range of sources to inform public health decisions, track the spread of disease, and evaluate the effectiveness interventions

Interoperable data infrastructure

Interoperable data infrastructure is key to connecting different systems and providing seamless access to data, enabling efficient and effective care delivery and research.

Data standards

Data standards are essential for ensuring consistency, accuracy, and interoperability, and for making it easier to share and analyze data across different systems, whether it is HL7 FHIR, DICOM, IHE, openEHR, CCR/CCD or others.

Data literacy/capacity in public health

Ensuring data literacy is crucial to making informed decisions and understanding the meaning behind public health data being analyzed and communicated

There's lots to do... get involved!

- Contribute to Open Data initiatives
- Join the conversation on PHAC's GitHub
  - ➢ https://github.com/phac-nml
  - ➢ https://github.com/PHACDataHub
- Careers at PHAC; need for data scientists and mathematicians
  - ➢ https://www.canada.ca/en/health-canada/campaigns/jobs-health-canada-public-health-agency-canada.html
- Conduct research in public health data science
- Collaborate with PHAC data scientists on research studies

Thank you!