
Health Surveillance:

*An Essential Tool
to Protect and
Promote the
Health of the Public*



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Health Surveillance:

An Essential Tool to Protect and Promote the Health of the Public

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People have known for a long time that collecting and using information is a powerful tool for improving the public's health. As early as 1662 in England, John Graunt suggested that data taken from death certificates should be analyzed to help improve the health of the public.¹ In the nineteenth century, William Farr began the practice of gathering and using vital statistics to describe the impact of diseases in various populations.²

Today, health surveillance is every bit as important as the information gathering that went on centuries ago. Indeed, in the wake of recent infectious disease outbreaks such as severe acute respiratory syndrome (SARS) and continuing chronic disease epidemics such as obesity, there have been repeated calls to improve the capacity of the public health system to carry out this important core function.

This insert explores the “what”, “why”, “how” and “now what” of health surveillance. It was written for a public health audience, but the concepts are relevant beyond this audience. Scenarios are used to show how surveillance concepts and skills can help communities take action to improve health. It emphasizes the need to enhance capacity at the local level and describes how the Skills Enhancement for Public Health Program of the Public Health Agency of Canada can help public health practitioners improve their surveillance skills.

What Is Health Surveillance?

Health surveillance is not only the collection of health data, but also “... the ongoing, systematic use of routinely collected health data to guide public health action in a timely fashion.”³ The health surveillance process cycles through three stages: data collection, analysis and interpretation, and the timely communication of findings.

The *data collection* stage begins by defining the public health actions and decisions that require information, and then choosing the best sources and methods for gathering the data that are needed. This often relies on agreements among partners to provide or share data and may need to balance competing needs for timeliness, simplicity and completeness. Key data collection approaches include:

- mandatory reporting of communicable disease cases, for example, tuberculosis, syphilis and whooping cough
- surveys of the environmental, behavioural and biological risk factors of populations,⁴ for example, smoking and physical activity

- use of existing administrative data about health events, for example, monitoring the number of injuries due to falls among seniors with hospital discharge data, or using provincial registries to provide information on the incidence and prevalence of different types of cancer
- detailed studies of selected population subgroups, for example, people living with HIV and AIDS, and of “cases” with particular characteristics in both human and animal populations, for example, identifying cases of variant Creutzfeldt Jacob disease in people and bovine spongiform encephalopathy or “Mad Cow Disease” in cattle
- voluntary reports on adverse outcomes due to drugs, vaccines, consumer products, accidents and vaccine-preventable or notifiable diseases.

The *analysis and interpretation* stage includes expert analysis of the data that have been collected to determine the occurrence of a health concern, and the characteristics and behaviours of people with a health concern, as well as changes over time. This is done by comparing age, sex and population groups, and looking at trends and other factors. For example, when analyzing smoking behaviour survey data, it is important to go beyond tabulating smoking rates by age and sex, and also look at whether the smoker has ever contemplated stopping smoking, is presently contemplating stopping, is prepared to stop, or has taken action to stop.

A variety of specialized methods are now available for a more thorough analysis of surveillance data, including geo-spatial analysis, life tables, logistic regression, and trend and small area analysis. While some of these methods may not be applicable to all diseases or risks of interest, the statistical and mapping tools are becoming more accessible to the casual analyst.

The analysis of surveillance data can signal the need for a rigorous scientific study with a specific hypothesis regarding causation. The data may also be used to produce regular reports and identify gaps or areas of concern that can lead to public health actions.

The final stage – the *timely communication of information* – is particularly important for follow-up action, as was evident during the SARS outbreak.⁵ Public health decision-making depends on three types of knowledge:

1. Knowledge based on research evidence.
Examples include a primary study showing the

impact of a health promotion program, a systematic review of studies on the effectiveness of public health programs and evidence-based best practice guidelines.

2. Knowledge based on experience. This includes the experiences of lay partners including patients and politicians, and professionals with health surveillance skills. For example, public health practitioners learn by experience how to manage a meningitis contact tracing emergency, handle the press effectively, investigate a complaint, work with “hard to reach” populations, and tackle deprivation and inequality.⁶
3. Knowledge based on statistics that measure health outcomes, health care performance and other determinants of health. This is largely derived from health surveillance. Examples include cancer registration rates in different populations, and new cases of respiratory disease in long-term care homes.

Public health practitioners need to understand and effectively communicate these three complementary types of knowledge. This may involve the use of a variety of communication vehicles such as formal surveillance reports or bulletins, annual reports, teleconferences with partners, media conferences, media releases, public advisories and intergovernmental notifications.

Why Do We Need Health Surveillance?

Public health practitioners, health planners, epidemiologists, researchers and policy-makers rely on surveillance to help them:

- make informed decisions related to program planning, evaluation, policies and resource allocation
- understand the economic and health impacts of a public health issue, and the nature and extent to which it disrupts communities
- understand the factors that cause health events, both at the individual and community level
- rapidly communicate information among public health officials and health care workers so they can take appropriate actions to resolve problems
- reduce the risk of the occurrence of public health crises
- strengthen activities that prevent and control diseases
- identify priorities and hypotheses for research.

Practitioners in other health sectors use surveillance data and reports to inform clinical decision-making. For example, awareness of the current status of

Health Surveillance: A Core Function in Public Health

A pan-Canadian initiative is underway to establish agreement on well-defined sets of core functions and competencies in public health. The Advisory Committee on Public Health has identified five core functions in public health:⁷

- health surveillance
- population health assessment
- health protection
- health promotion
- disease and injury prevention.

Two additional core functions have been identified in several consultation meetings and reports: emergency response and preparedness, and population health advocacy.

Public health core functions* are a set of essential actions carried out within the public health system specifically to achieve the central objective of public health – optimizing the health of the population. Core functions are interdependent and all are required within a fully effective and responsible public health system.

Public health core competencies† are a set of cross-cutting skills, knowledge and abilities that individuals need to be able to properly carry out each and all of the public health functions.

* Working description based on definitions used by the Pan American Health Association (PAHO) and the Nova Scotia Public Health Services.

† Working description used at a national consultation held in St. John's, NL in June 2004 at the annual conference of CPHA.

respiratory diseases in the local community and worldwide is useful for individual patient care as well as policy-setting in hospitals and other care facilities.

The following scenario demonstrates why health surveillance is critical to public health and how understanding and using concepts to monitor threats to health can help communities make better decisions.

Scenario 1: Responding to the Contamination of Public Water Supplies

In Walkerton, Ontario, a town of 4,800 people, *E. coli* O157 bacteria in the drinking water caused more than 2,300 people to become sick and left 7 dead.⁸

Just prior to the Victoria Day weekend in 2000, an Owen Sound pediatrician first sounded the alarm when she reported two patients with bloody diarrhea to the local public health unit, as is required by law. Alert public health practitioners then checked with the local hospital and school, and found that other milder cases of bloody diarrhea were occurring in the community.

The outbreak management team knew that the greatest concern – *E. coli* O157 bacteria – causes diarrhea so severe that children need to be hospitalized, sometimes with kidney failure. They immediately asked about the safety of the local water supply but received a report from the town’s utility manager that the water was safe. Public health inspectors looked for other culprits: contaminated hamburger meat, raw milk, a dirty restaurant. They found no useful clues.

The outbreak management team contacted the area hospitals to share their findings. They informed them of the need to be prepared for additional cases and to implement care and infection control procedures.

On the basis of the information available, the Medical Officer of Health ordered a boil water advisory. He called each family with an ill child under age five to make sure that the parents knew the signs of kidney failure. The outbreak management team “mapped out” the location of 120 people suffering from bloody diarrhea. This supported their suspicion of a community-wide water-borne contamination.

Provincial and federal epidemiologists, clinicians and laboratory experts were invited to join the outbreak team. Over the two-week period that followed, up to 1,000 people reported the same symptoms.

Following the long weekend, an independent water test confirmed that the town water was contaminated. By then, a 66-year-old woman and a 2-year-old girl had died and a dozen people had been hospitalized. The local utility water manager reported that the town’s chlorinator was not functioning properly. It became clear that town officials and the water utility staff did not understand the link between the need for water quality surveillance and the health of the community, including the dissemination of regular water quality reports from the private firm contracted to test the water. The decision not to purchase and install automatic chlorine residual monitors in the town’s wells reflected this lack of understanding.

Lessons Learned from the Contaminated Water Scenario

Here are some of the lessons learned about health surveillance in this scenario:

- Timeliness is critical. The prompt notification of a serious disease by the pediatrician immediately set the outbreak management process into action.
- Health surveillance is more than counting disease cases. In this scenario, communication of results among the public health authorities, the hospital, and health professionals was well managed. However, accurate and reliable feedback on water quality was missing.
- Health surveillance involves the continuous monitoring of data collected on health risks (in this case, water tests) and cases of illness. Further surveillance after the outbreak helped to ensure there was no further potential for outbreaks and everyone was performing assigned functions properly.
- Community staff and decision-makers in the community need to make health surveillance a priority.
- Employees at all levels who are involved in the quality control of environmental factors need to understand the important role of surveillance and the implications of their actions in protecting and promoting the public’s health.

How is Health Surveillance Carried Out?

The following scenario describes how one type of surveillance system – a sentinel events influenza surveillance system – operates in the community, and how it can support timely responses to outbreaks through the collection, analysis and communication of information from multiple sites.

Scenario 2: A Surveillance System for Influenza

Influenza contributes to high work absenteeism, long waits in emergency rooms, and high morbidity and mortality among older and immuno-compromised people. Flu prevention through immunization is more cost-beneficial than after-the-fact treatment of the disease.⁹ Immunization programs to prevent influenza among vulnerable groups are supported in most jurisdictions, but the vaccines are not perfect and the viruses change from year to year.

In order to determine local trends in new cases of influenza and to ensure a timely response to outbreaks, the public health department worked with the province to establish an influenza sentinel events surveillance system that operates across a number of regional health authorities. Specific physicians and

institutions were asked to complete easy-to-use forms related to cases of influenza. In addition, public health professionals worked with stakeholders in settings where people often present with influenza-like illnesses, such as daycare centres, schools, acute- and long-term care facilities, and workplaces. In this way, the regional health authorities contributed to provincial, federal and international surveillance systems, including the Public Health Agency's FluWatch. This allowed the public health community to be more prepared for a widespread outbreak across continents or worldwide.

One of the first tasks of the surveillance team was to ensure a common understanding and comparable 'case definition' of influenza. Influenza has variable symptoms, so a consistent definition is critical to tracking it locally and at a global level. The team consulted many colleagues throughout Canada and at the World Health Organization, which had just finalized a *Global Agenda on Influenza Surveillance*.¹⁰ Consequently, they were able to develop a consistent and useful definition of influenza for surveillance purposes.

This type of surveillance network focusses on the early reporting of flu-like illnesses in an attempt to monitor influenza activity and trends. This should provide the health community and public with the warning time needed to perform appropriate interventions. It should also help to limit suffering due to influenza, particularly in more vulnerable groups. For example, when surveillance data establish an increased occurrence of influenza, public health officials can advise long-term care facilities to put preventive measures in place, including limiting visitors. The system should result in financial savings to the community by being able to anticipate local and global epidemics, providing more effective vaccine coverage and ensuring more timely action to reduce the impact of flu outbreaks. Tracking changes in the influenza virus also assists in making decisions for subsequent vaccine components.

Lessons Learned from the Influenza Surveillance Scenario

Here are some of the lessons learned about health surveillance in this scenario:

- Multiple stakeholders must be involved. This not only strengthens the surveillance system, but also enhances the key participants' knowledge, skills and willingness to participate.
- Common case definitions, and simple, effective reporting mechanisms and procedures must be developed.

- A successful sentinel events surveillance system is not expensive and works in tandem with a number of other public health activities, for example, the laboratory identification of viruses.
- When combined with other data sources, a successful sentinel events surveillance system provides information that is sensitive yet specific enough to enable rapid, timely responses in the event of an outbreak.

How is Health Surveillance Used in Association with Policy Decisions?

The following scenario demonstrates how health surveillance is particularly important in monitoring the impact of a national policy over time.

Scenario 3: The Prevention of Neural Tube Defects

Data from the Canadian Congenital Anomalies Surveillance System showed that although there was a decline in neural tube defects in Canada between 1990 and 1997, rates were still of concern, particularly in Newfoundland.¹¹ Earlier studies suggested that women who increased their intake of folic acid in the periconceptional period (the time before and after conception) had a reduced risk of NTDs.¹²⁻¹⁵ In 1991 and 1992, two randomized controlled trials provided strong evidence for the protective effect of folic acid.^{16,17} Because many pregnancies are unplanned, and it is difficult to have all women who could become pregnant take a daily vitamin supplement, fortification was proposed as a "passive" public health measure. In November 1998, Canada announced that, like the United States, it would require folic acid fortification of white flour, enriched pasta and cornmeal.

During the discussion about fortification, some concerns were expressed:

- It appears that even optimal levels of folic acid will not prevent all cases of neural tube defects.
- Not all women eat grain products – people with celiac disease, for example, cannot tolerate wheat products.
- Women who consume only whole grains will not get the benefit of folic acid fortification.
- Some people who consume a lot of breads may be getting too much folic acid. In older people, for example, increased intake of folic acid can mask the signs of vitamin B12 deficiency.

Because of these concerns, Health Canada, in collaboration with colleagues from Memorial University in St. John's, Newfoundland and KFL&A Public Health in Kingston, Ontario, evaluated the effects of this policy in 1) St. John's,

2) the Clarendon/Random Island/Port Blandford area of Newfoundland, and 3) the counties of Frontenac and Lennox & Addington, including Kingston, in Ontario.¹⁸ Surveillance of neural tube defects in several Canadian provinces and in the United States provides important outcome data for further evaluation of this policy.

Lessons Learned from Preventing Neural Tube Defects Scenario

Here are some of the lessons learned about health surveillance in this scenario:

- Surveillance provides baseline data that are used to assess the magnitude of a problem and to aid decision-making about a policy, by allowing the calculation of costs and benefits.
- Surveillance is necessary, but not sufficient, for most public health policy-making. Research studies, their syntheses, and expert input provide the scientific background needed to define and decide on the specific policy intervention.
- Continuous surveillance is required to monitor and evaluate the effects of policy decisions. In this case, there is a clear need for continued surveillance, both for neural tube defects and for other problems that may be associated with higher levels of folic acid.

Now What?

Building Capacity for Health Surveillance

Numerous recent reports as well as highly publicized disease outbreaks, for example, Walkerton, SARS, West Nile Virus and Mad Cow Disease, have stressed the urgent need to strengthen the capacity of public health in Canada. Central to this is a national, provincial/territorial, regional and local public health human resource strategy. No attempt to meet the current challenges in public health will succeed unless it recognizes the fundamental importance of providing and maintaining a cadre of highly trained and motivated public health professionals in every local health agency in Canada.⁷

In the past, health surveillance information was not readily available. Now the Internet and a number of initiatives by the federal government and others have increased access to health information and surveillance products. This allows a broader range of the public health workforce to use surveillance information to better prioritize, plan, deliver and evaluate programming. To perform these tasks, public health staff must possess the required knowledge and skills. While it is neither feasible nor necessary for all staff to receive post-graduate academic training, a

greater proportion of the public health workforce need to acquire the knowledge and skills necessary to effectively understand and use surveillance concepts and techniques.

Once limited to use by analysts and researchers, complex tools such as geographic information systems, database management software, statistical and epidemiological analyses are becoming widely accessible. New tools can support increased use of surveillance data and lead to improved decision-making. However, they impose additional requirements:

- Higher quality data and more of it, especially more detailed exposure and outcome data on individuals.
- Skills that match the tools. While new software can lessen the technical burden of managing and analyzing data, it does not diminish the need for a thorough understanding of the data, the analytic methods and the interpretation of results.

Here are some ways in which management and members of boards of health can support and strengthen surveillance skills and capacity development.

Strengthen health surveillance systems by:

- allocating resources, including human resources,* for the effective use of health surveillance data and tools
- recognizing the need for existing staff to acquire new skills, and for dedicated staff at the regional or provincial/territorial level to manage new systems
- making a commitment to high-quality data collection and analysis, and to timely reporting to all stakeholders
- simplifying and standardizing the management of public health information[†]
- improving access to local, regional and national surveillance data to ensure high-quality information from the local to the global level
- providing all staff who make program decisions with access to surveillance information
- supporting professional networking in surveillance.

* A more thorough discussion of strategies for public health human resources is beyond the scope of this paper, but readers are encouraged to participate in local, regional or national discussions on related issues, including competency profiles for public health practitioners, undergraduate and graduate training, continuing education, and funding for public health.

† The Public Health Agency of Canada has launched a system for sharing information on potential outbreaks at the national or provincial/territorial level (CIOSC) and has supported the implementation of iPHIS in many provinces (http://www.phac-aspc.gc.ca/surveillance_e.html).

Upgrade and strengthen staff and management skills in surveillance by:

- collaborating with universities, colleges, the Skills Enhancement for Public Health Program and others to provide public health practitioners with opportunities to improve their surveillance skills and knowledge through project work and courses
- developing and implementing strategies to recruit and retain specialists and staff with surveillance expertise
- including surveillance capacity in accreditation standards and job descriptions
- participating in initiatives to ensure that surveillance and surveillance skills are adequately identified as core functions and core competencies in public health.

Conclusion

The three scenarios described in this article demonstrate the importance of surveillance in protecting and promoting the public's health. Canada cannot afford to wait for another outbreak before taking action. We need an effective public health system that employs and trains qualified practitioners in the skills and methodologies of health surveillance now.

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The Skills Enhancement for Public Health Program

The Skills Enhancement for Public Health Program is an Internet-based continuing education initiative for front-line public health professionals across Canada. It is designed to increase their skills in epidemiology, surveillance and information management. The core component is a series of distance-learning modules in both official languages. Over 1,200 public health professionals have successfully completed at least one of the five existing modules. The new surveillance module will be released in the fall of 2006. The overall aim of this module is to raise the level of awareness and knowledge of the principles and practices of contemporary health surveillance and enhance the skills needed to participate in the various aspects of the health surveillance cycle. For more information about this continuing education opportunity, please contact skills@phac-aspc.gc.ca.

The Skills Enhancement for Public Health Program is based in the Public Health Agency of Canada. For more information, please visit www.phac-aspc.gc.ca/skills.