**Introduction**

In late fall of 2002, severe acute respiratory syndrome (SARS) appeared in China. By March 2003, SARS had become recognized as a global threat. According to World Health Organization (WHO) data, more than 8,000 people from 29 countries became infected with this previously unknown virus and more than 700 people died. By 2004, the last SARS cases were caused by laboratory-acquired infections. Because of computerized global data collection, the potentially negative impact of a widespread global epidemic was averted.

Additionally, [**Renwick (2016)**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib40) reported that

*[b]y the end of 2015, more than 28,600 people had been infected [with Ebola], killing more than 11,300. That figure was much lower than projections the CDC made a year before, which calculated that as many as 1.4 million people could become infected with Ebola by January 2015. Instead, the disease peaked in late 2014: in Liberia in September, Guinea in October, and Sierra Leone in November. By January 2016, Guinea, Liberia, and Sierra Leone had been declared free of Ebola. (para. 16)*

As we lived through the Ebola outbreak, we realized the need for timely information to be shared with the world population, as well as the healthcare workers responsible for caring for them. [**WHO (2015)**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib46) stated that “leading international stakeholders from multiple sectors convened at a WHO consultation in September 2015, where they affirmed that timely and transparent pre-publication sharing of data and results during public health emergencies must become the global norm” (para. 1).

More recently, the Zika virus has become a leading public health concern. The Centers for Disease Control and Prevention ([**CDC; 2016b**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib15)) reported that their Emergency Operations Center (EOC)

*was activated for Zika on January 22, 2016, and moved to a level 1 activation—the highest level—on February 8, 2016. The EOC is the command center for monitoring and coordinating the emergency response to Zika, bringing together CDC scientists with expertise in arboviruses like Zika, reproductive health, birth defects, and developmental disabilities, and travel health. (para. 1)*

The CDC’s EOC staff works in collaboration with local, national, and international response partners to analyze, validate, and efficiently exchange information about the outbreak. The [**CDC (2015)**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib13) public health surveillance center “refers to the collection, analysis and use of data to target public health prevention. It is the foundation of public health practice” (para. 1). The CDC provides interactive databases and surveys, as well as methods to guide conducting and evaluating surveillance systems and data standardization.

Many [**surveillance**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/37_glossary.xhtml#gloss49) systems, loosely termed “syndromic surveillance systems,” use data that are not diagnostic of a disease but that might indicate the early stages of an outbreak (see [**Figure 17-1**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-fig1)). Outbreak detection is the overriding purpose of [**syndromic surveillance**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/37_glossary.xhtml#gloss684) for terrorism preparedness. Enhanced case finding and monitoring the course and population characteristics of a recognized outbreak also are potential benefits of syndromic surveillance. In recent years, new data have been used by public health officials to enhance surveillance, such as patients’ chief complaints in emergency departments, ambulance log sheets, prescriptions filled, retail drug and product purchases, school or work absenteeism, and medical signs and symptoms in persons seen in various clinical settings. With faster, more specific, and more affordable diagnostic methods and decision-support tools, timely recognition of reportable diseases with the potential to lead to a substantial outbreak is now possible. Tools for pattern recognition can be used to screen data for patterns needing further public health investigation. For example, during the 2003 SARS epidemic, the [**Centers for Disease Control and Prevention (CDC)**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/37_glossary.xhtml#gloss81) worked to develop surveillance criteria to identify persons with SARS in the United States, and the surveillance case definition changed throughout the epidemic, to reflect increased understanding of SARS ([**CDC, 2013**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib11)).

**Figure 17-1** Syndromic Surveillance System

Information acquired by the collection and processing of population health data becomes the basis for knowledge in the field of [**public health**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/37_glossary.xhtml#gloss15). There is an ever-increasing need for timely information about the health of communities, states, and countries. Knowledge about disease trends and other threats to community health can improve program planning, decision making, and care delivery. Patients seen from the perspective of major health threats within their communities can benefit from opportunities for early intervention.

This chapter focuses on the application of informatics methods to public health surveillance. The availability of clinical information for public health has been fundamentally changed by the introduction of the electronic health record (EHR) and health information technology (IT), which now give public health “an unprecedented opportunity to leverage the information, technologies and standards to support critical public health functions such as alerting and surveillance” ([**Garrett, 2010**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib19)).

**Core Public Health Functions**

The core public health functions are as follows:

* The assessment and monitoring of the health of communities and populations at risk to identify health problems and priorities
* The formulation of public policies designed to solve identified local and national health problems and priorities
* To assure that all populations have access to appropriate and cost-effective care, including health promotion and disease prevention services, and evaluation of the effectiveness of that care ([**Medterms Medical Dictionary, 2007**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib29))

Public health focuses on health promotion and disease prevention. According to the [**CDC Foundation (2016)**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib07), public health is the

*science of protecting and improving the health of families and communities through promotion of healthy lifestyles, research for disease and injury prevention and detection and control of infectious diseases. Overall, public health is concerned with protecting the health of entire populations. These populations can be as small as a local neighborhood, or as big as an entire country or region of the world. (para. 1–2)*

Historically, Dr. John Snow can be designated as the “father” of [**public health informatics**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/37_glossary.xhtml#gloss460) (PHI) ([**Figure 17-2**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-fig2)). In 1854, he plotted information about cholera deaths and was able to determine that the deaths were clustered around the same water pump in London. He convinced authorities that the cholera deaths were associated with that water pump; when the pump handle was removed, the cholera outbreak ended. It was Dr. Snow’s focus on the cholera-affected population as a whole rather than on a single patient that led to his discovery of the source of the cholera outbreak ([**Vachon, 2005**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib45)).

**Figure 17-2** Public Health Informatics

Florence Nightingale should also be recognized as an early public health informaticist. Her recommendations about medical reform and the need for improved sanitary conditions were based on data about morbidity and mortality that she compiled from her experiences in the Crimea and England. Her efforts led to a total reorganization of how and which healthcare statistics were collected ([**Dossey, 2000**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib16)).

Just as information has been recognized as an asset in the business world, so health care is now recognized as an information-intensive field requiring timely, accurate information from many different sources. Health information systems address the collection, storage, analysis, interpretation, and communication of health data and information. Many health disciplines, such as medicine and nursing, have developed their own concepts of informatics. That trend has reached the field of public and community health. PHI represents “the effective use of information and information technology to improve public health practice and outcomes” ([**Public Health Informatics Institute, 2015**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib37), para. 18). This area of informatics differs from others because it is focused on the promotion of health and disease prevention in populations and communities. PHI efficiently and effectively organizes and manages data, information, and knowledge generated and used by public health professionals to fulfill the core functions of public health: assessment, policy, and assurance ([**Agency for Toxic Substances and Disease Registry [ATSDR], 2016**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib01)). Public health changes the social conditions and systems that affect everyone within a given community. It is because of public health initiatives that people understand the importance of clean water, the dangers of second-hand smoke, and the fact that seat belts really do save lives. PHI emphasizes community-based solutions and promotes community empowerment by advancing the state of the art in community benefit projects ([**Public Health Institute, 2016a**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib38)). One of the community-based projects—Building Healthy Communities: Hospital Community Benefit Engagement—applies “findings and lessons learned from the collection and analysis of community benefit programming data in the 14 building healthy community sites to create deeper collaboration and partnership-building” ([**Public Health Institute, 2016b**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib39), para. 1). Community empowerment can be realized through the collaborative collection and analysis of data that lead to improved community health outcomes and transformed public health.

The scope of PHI practice includes knowledge from a variety of additional disciplines, including management, organization theory, psychology, political science, and law, as well as fields related to public health, such as [**epidemiology**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/37_glossary.xhtml#gloss231), microbiology, toxicology, and statistics ([**O’Carroll, Yasnoff, Ward, Ripp, & Martin, 2003**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib33), p. 5). PHI addresses the data, information, and knowledge that public health professionals generate and use to meet the core functions of public health. [**Yasnoff and colleagues (2000)**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib48) defined four principles that continue to define and guide the activities of PHI: (1) applications promote the health of populations, (2) applications focus on disease and injury prevention, (3) applications explore prevention at “all vulnerable points in the causal changes,” and (4) PHI reflects the “governmental context in which public health is practiced” (p. 69).

Functions of public health include prevention of epidemics and the spread of disease, protection against environmental hazards, promotion of health, disaster response and recovery, and providing access to health care.

The initiative of integrating the healthcare enterprise to ensure that healthcare information can be shared more easily and used more effectively has inspired the creation of the domain known as [**quality, research, and public health (QRPH)**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17key14). Participants in this domain address the repurposing of clinical, demographic, and financial data collected in the process of providing clinical care to the monitoring of disease patterns; incidence, prevalence, and situational awareness of such patterns; and the identification of new patterns of disease not previously known or anticipated. Such data can be incorporated within existing public health population analyses and programs for direct outreach and condition management through registries and locally determined appropriate treatment programs or protocols.

**Community Health Risk Assessment: Tools for Acquiring Knowledge**

As the public has become more aware of harmful elements in the environment, [**risk assessment**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/37_glossary.xhtml#gloss125) tools have been developed. Such tools allow assessment of pesticide use, exposure to harmful chemicals, contaminants in food and water, and toxic pollutants in the air to determine if potential hazards need to be addressed. A risk assessment may also be called a “threat and risk assessment.” A “threat” is a harmful act, such as the deployment of a virus or illegal network penetration. A “risk” is the expectation that a threat may succeed and the potential damage that can occur ([**PCMag.com Encyclopedia, 2007**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib36)). “Risk factor assessments complement vital statistics data systems and morbidity data systems by providing information on factors earlier in the causal chain leading to illness, injury or death” ([**O’Carroll, Powell-Griner, Holtzman & Williamson, 2003**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib32), p. 316).

The U.S. Environmental Protection Agency ([**EPA; 2016**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib44)) “uses risk assessments to characterize the nature and magnitude of health risks to humans (e.g., residents, workers, recreational visitors) and ecological receptors (e.g., birds, fish, wildlife) from chemical contaminants and other stressors, that may be present in the environment” (para. 3) and are used to weigh the benefits and costs of various program alternatives for reducing exposure to potential hazards. They may also influence public policy and regulatory decisions. Health risk assessment is a constantly developing process based in sound science and professional judgments. There are usually four basic steps ascribed to risk assessment (see also [**Figure 17-3**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-fig3)):

**Figure 17-3** Four-Step Risk Assessment Process

Modified from U.S. Environmental Protection Agency. ([**2016**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib44)). Conducting a human health risk assessment. Retrieved from [**https://www.epa.gov/risk/conducting-human-health-risk-assessment**](https://www.epa.gov/risk/conducting-human-health-risk-assessment)

1. *Hazard identification* seeks to determine the types of health problems that could be caused by exposure to a potentially hazardous material. All research studies related to the potentially hazardous material are reviewed to identify potential health problems.
2. *Exposure assessment* is done to determine the length, amount, and pattern of exposure to the potentially hazardous material.
3. *Dose–response assessment* is an estimation of how much exposure to the potential hazard would cause varying degrees of health effects.
4. *Risk characterization* is an assessment of the risk of the hazardous material causing illness in the population ([**California Environmental Protection Agency, 1998**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib06)).

The overall question the risk assessment has to answer is, “How much risk is acceptable?” Risk factor systems are used throughout the United States and may be local, regional, or national in scope. Specific risk assessment tools exist for specific health issues, such as the [**Suicide Prevention Community Assessment Tool**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/37_glossary.xhtml#gloss677), which addresses general community information, prevention networks, and the demographics of the target population and community assets and risk factors. Other risk assessment tools include the [**Youth Risk Behavior Surveillance System**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/37_glossary.xhtml#gloss787), the [**Behavioral Risk Factor Surveillance System**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/37_glossary.xhtml#gloss49), and the [**National Health and Nutrition Examination Survey**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/37_glossary.xhtml#gloss462).

Determining the presence of risk factors in a community is a key part of a [**community risk assessment (CRA)**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/37_glossary.xhtml#gloss125). Communities may be concerned about which elements in the environment affect or may affect the community’s health, the level of environmental risk, and other factors that should be included in public health planning. [**Ball (2003)**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib02) defined value as “a function of cost, service, and outcome” (p. 41). The value of a CRA derives from its ability to provide information crucial to planning, build consensus regarding how to mobilize community resources, and allow for comparison of risks with those of other communities. The goal of a CRA is risk reduction and improved health. A CRA may identify unmet needs and opportunities for action that may help set new priorities for local public health units. It may also be used to monitor the impact of prevention programs.

**Processing Knowledge and Information to Support Epidemiology and Monitoring Disease Outbreaks**

There is a need to define the role of federal, state, and local public health agencies in the development of PHI and IT applications. The availability of IT today challenges all stakeholders in the health of the public to adopt new systems that can provide adequate disease surveillance; it also challenges people to improve outmoded processes.

Preparedness in public health requires more timely detection of potential health threats, situational awareness, surveillance, outbreak management, countermeasures, response, and communications. Surveillance uses health-related data that signal a sufficient probability of a case or an outbreak that warrants further public health response. Although historically syndromic surveillance has been used to target investigations of potential infectious cases, its use to detect possible outbreaks associated with [**bioterrorism**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/37_glossary.xhtml#gloss57) is increasingly being explored by public health officials ([**CDC, 2013**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib11), [**2014**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib12)). Early detection of possible outbreaks can be achieved through timely and complete receipt, review, and investigation of disease case reports; by improving the ability to recognize patterns in data that may be indicative of a possible outbreak early in its course; and through receipt of new types of data that can signify an outbreak earlier in its course. Such new types of data might include identification of absences from work or school; increased purchases of healthcare products, including specific types of over-the-counter medications; presenting symptoms to healthcare providers; and laboratory test orders ([**CDC, 2012**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib10), [**2013**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib11)). The University of Pittsburgh’s Real-time Outbreak and Disease Surveillance Laboratory (RODS), for example, developed the National Retail Data Monitor (NRDM) system. The NRDM collects data on over-the-counter medications and other healthcare products from 28,000 stores and uses computer algorithms to detect unusual purchase patterns that might potentially signal a disease outbreak ([**RODS Laboratory, 2013**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib41)). A comprehensive surveillance effort supports timely investigation and identifies data needs for managing the public health response to an outbreak or terrorist event. Informatics tools are becoming increasingly important in these public health efforts.

To appropriately process public health data, PHI has a need for a standardized vocabulary and coding structure. This is especially important as national public health data are collected and data mining performed so that data variables can be understood across systems and between agencies. Health information organizations (HIOs) have been established to support data sharing via health information exchanges (HIE) promoted by the meaningful use criteria of the EHR. Central to these initiatives is the need for standardized codes and terminologies that may be used by the HIOs to map data from disparate sources ([**Hyde et al., 2013**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib24); [**Shapiro, Mostashari, Hripcsak, Soulakis, & Kuperman, 2011**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib42)).

In the early 1990s, the CDC launched a plan for an integrated surveillance system that moved from stand-alone systems to networked data exchange built with specific standards. Early initiatives were the National Electronic Telecommunications System for Surveillance and the Wide-ranging Online Data for Epidemiologic Research. Six current initiatives reflect this early vision:

1. PulseNet USA: A surveillance network for food-borne infections.
2. National Electronic Disease Surveillance System: Facilitates reporting on approximately 100 diseases, with data feeding directly from clinical laboratories, which allows for early detection.
3. Epidemic Information Exchange: A secure communication system for practitioners to access and share preliminary health surveillance information.
4. Health Alert Network: A state and nationwide alert system.
5. Biosense: Provides improved real-time biosurveillance and situational awareness in support of early detection.
6. Public Health Information Network: Promotes standards and software solutions for the rapid flow of public health information.

Certainly, the events of September 11, 2001, which indicated the need for the United States to increase its efforts directed toward prevention of terrorism, accelerated the need for informatics in public health practice. Today, response requirements include fast detection, science, communication, integration, and action ([**Kukafka, 2006**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib26)). In 2005, the CDC created the [**National Center for Public Health Informatics (NCPHI)**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/37_glossary.xhtml#gloss460) to provide leadership in the field. This center aims to protect and improve health through PHI ([**CDC, 2005**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib09); [**McNabb, Koo, Pinner, & Seligman, 2006**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib28)). The [**CDC (2016a)**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib14) “provides leadership and crosscutting support in developing public health information systems, managing public health surveillance programs and providing health-related data required to monitor, control, and prevent the occurrence and spread of diseases and other adverse health conditions” (para. 1).

Information is vital to public health programming. The data processed into public health information can be obtained from administrative, financial, and facility sources. Included in this data stream may be encounter, screening, registry, clinical, and laboratory and surveillance data. It has been recommended that the functions of population health beyond surveillance be integrated into the EHR and the personal health record. Such an initiative might allow for population-level alerts to be sent to clinicians through these electronic record systems. Systems now being developed allow for automated syndromic surveillance of emergency department records and media surveillance, which in turn supports early detection of potential pandemic occurrences. Such systems were tested during the 2009 H1N1 flu, 2014 Ebola, and 2015 Zika outbreaks. The public health–enhanced electronic medical record can provide immediate detection and reporting of notifiable conditions. The incorporation of geographic information systems allows public health data to be mapped to specific locations that may indicate an immediate need for intervention ([**CDC, 2016a**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib14); [**Grannis & Vreeman, 2010**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib20)).

Vital statistics from state and local governments are also used for public health purposes. It should be noted that databases created with public funds are public databases that are available for authorized public representatives for public purposes ([**CDC, 2016a**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib14); [**Freedman & Weed, 2003**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib17)).

The widespread implementation of EHRs is facilitating the concept of a public health–enabled record, which can automatically send patient information alerts from the point of care to public health departments when reportable symptoms, conditions, or diseases are encountered. A public health–enabled EHR can be bidirectional, allowing public health information and recommendations for treatment to be accessible at the point of care. One public health EHR prototype addresses the information flow related to newborn screenings ([**HealthIT.gov, 2013a**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib21); [**Orlova et al., 2005**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib35)).

Potential applications of HIE to public health have been described by [**HealthIT.gov (2013b)**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib22) and [**Shapiro et al. (2011)**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib42). They include syndromic surveillance using data generated from mandated and nonmandated laboratory results, physician diagnoses, and emergency or clinic chief complaints; strategies to locate loved ones in mass-casualty events; and public health alerts at the individual and population levels.

**Applying Knowledge to Health Disaster Planning and Preparation**

The availability of data and the speed of data exchange can have a significant impact on critical public health functions such as disease monitoring and syndromic surveillance. Currently, surveillance data are limited and historical in nature, although this situation is rapidly changing. Nevertheless, special data collections are needed to address specific public health issues, and investigations and emergencies are still frequently addressed and managed with paper. In the future, PHI will make real-time surveillance data available electronically, and investigations and emergences will be managed with the tools of informatics ([**Yasnoff et al., 2004**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib47)). [**Surveillance data systems**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/37_glossary.xhtml#gloss681) such as infectious disease trackers that collect data on adverse health effects are invaluable tools for public health officials to tap for planning, evaluation, or implementation of [**public health interventions**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/37_glossary.xhtml#gloss575). The [**Agency for Toxic Substances and Disease Registry (ATSDR)**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/37_glossary.xhtml#gloss15), for example, is a federal agency that acts as a repository for research and data regarding hazardous materials. It “serves the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and diseases related to toxic substances” ([**ATSDR, 2016**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib01), para. 1). “Syndromic surveillance for early outbreak detection is an investigational approach where health department staff, assisted by automated data acquisition and generation of statistical signals, monitor disease indicators continually (real-time) or at least daily (near realtime) to detect outbreaks of diseases earlier and more completely than might otherwise be possible with traditional public health methods” ([**Buehler, Hopkins, Overhage, Sosin, & Tong, 2004**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib05), para. 7). Traditionally, there has been no common infrastructure to respond to pandemics, but the development of health IT is creating opportunities that go far beyond national boundaries to impact global public health initiatives. In this vein, the [**U.S. Department of Homeland Security (2015)**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib43) has a national strategy for pandemic flu that is designed to meet three critical goals:

1. Detecting human or animal outbreaks that occur anywhere in the world
2. Protecting the American people by stockpiling vaccines and antiviral drugs while improving the capacity to produce new vaccines
3. Preparing to respond at the federal, state, and local levels in the event an avian or pandemic influenza reaches the United States (para. 1)

In New York City, a primary care information project funded by the CDC developed a multifaceted initiative, the Center for Excellence in Public Health Informatics, to address issues of measurement of meaningful use, disease and outbreak surveillance, and decision support alerts at the point of care ([**Buck, Wu, Souliakis, & Kukalka, 2010**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib04); [**Hripcsak, 2015**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib23)).

**Informatics Tools to Support Communication and Dissemination**

The revolution in IT has made the capture and analysis of health data and the distribution of healthcare information more achievable and less costly. Since the early 1960s, the CDC has used IT in its practice; PHI emerged as a specialty in the 1990s. PHI has become more important with improvements in IT; changes in the care delivery system; and the challenges related to emerging infections, resistance to antibiotics, and the threat of chemical and biologic terrorism. Two-way communication between public health agencies, community, and clinical laboratories can identify clusters of reportable and unusual diseases. In turn, health departments can consult on case diagnosis and management, alerts, surveillance summaries, and clinical and public health recommendations. Ongoing healthcare provider outreach, education, and 24-hour access to public health professionals may lead to the discovery of urgent health threats. The automated transfer of specified data from a laboratory database to a public health data repository improves the timeliness and completeness of reporting notifiable conditions.

Public health information systems represent a partnership of federal, state, and local public health professionals. Such systems facilitate the capture of large amounts of data, rapid exchange of information, and strengthened links among these three system levels. Dissemination of prevention guidelines and communication among public health officials, clinicians, and patients has emerged as a major benefit of PHI. IT solutions can be used to provide accurate and timely information that guides public health actions. In addition, the Internet has become a universal communications pathway and allows individuals and population groups to be more involved and take greater responsibility for management of their own health status.

Few public health professionals have received formal informatics training, and many may not be aware of the potential impact of IT on their practice. A working group formed at the University of Washington Center for PHI has published a draft of PHI competencies needed ([**Karras, 2007**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib25)). These competencies include the following:

* Supporting development of strategic direction for PHI within the enterprise
* Participating in development of knowledge management tools for the enterprise
* Using standards
* Ensuring that the knowledge, information, and data needs of project or program users and stakeholders are met
* Managing information system development, procurement, and implementation
* Managing IT operations related to a project or program (for public health agencies with internal IT operations)
* Monitoring IT operations managed by external organizations
* Communicating with cross-disciplinary leaders and team members
* Participating in applied public health informatics research
* Developing public health information systems that are interoperable with other relevant information systems
* Supporting use of informatics to integrate clinical health, environmental risk, and population health
* Implementing solutions that ensure confidentiality, security, and integrity, while maximizing availability of information for public health
* Conducting education and training in PHI ([**Center for Public Health Informatics, 2007**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib08))

**Using Feedback to Improve Responses and Promote Readiness**

Improvement of community health status and population health depends on effective public and healthcare infrastructures. In addition to information from public health agencies, there is now interest in the capture of information from hospitals, pharmacies, poison control centers, laboratories, and environmental agencies. Timely collection of such data allows early detection and analysis, which can increase the rapidity of response with more effective interventions. [**Yasnoff et al. (2000)**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib48) identified the “grand challenges” still facing PHI as the development of national public health information systems, a closer integration of clinical care with public health, and concerns of confidentiality and privacy. Since then, great strides have been made towards a national public health information system, but we currently are still striving to make this a true reality. At present, there is a 10-year vision to achieve an interoperable health IT infrastructure in the United States ([**Office of the National Coordinator for Health Information Technology, 2014**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib34)).

Population health data must be considered an important part of the infrastructure of all [**regional health information exchanges**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/37_glossary.xhtml#gloss606), which are the building blocks for a [**national health information network**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/37_glossary.xhtml#gloss464). Organizations and agencies interested in promoting and protecting the public’s health must commit to collaboration and seamless data sharing ([**Office of the National Coordinator for Health Information Technology, 2014**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib34)). Public health data include data related to surveillance, environmental health, and preparedness systems as well as client information, such as data from immunization registries and laboratory results reporting and analysis. These types of data can provide information about outbreaks, patterns of drug-resistant organisms, and other trends that can help improve the accuracy of diagnostic and treatment decisions and advance public health research ([**LaVenture, 2005**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib27); [**National Institutes of Health, 2016**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib31)). A regional health information exchange and national health information network can also support public health goals through broader opportunities for participation in surveillance and prevention activities, improved case management and care coordination, and increased accuracy and timeliness of information for disease reporting (LaVenture).

Much of the information is focused on reaction to issues and timely intervention, rather than harnessing information technology for disease prevention. [**Fuller (2011)**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib18) advocated for a shift to prevention informatics by harnessing real-time social data and aggregating and representing these data in a meaningful way so that an appropriate prevention response can be mounted. For example, Internet searches related to flu symptoms might prompt a public health prevention response such as a school closure to minimize spread. Newer software tools to support mapping and real-time data visualization include Riff and Ushahidi, each of which supports “gathering of distributed data from the web and other data streams” (Fuller, p. 40). “Prevention informatics offers a useful paradigm for re-imagining health information systems and for harnessing the vast array of data, tools, technologies and systems to respond proactively to health challenges across the globe” (Fuller, p. 41).

Harnessing data from [**social media**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/37_glossary.xhtml#gloss160) such as Twitter and Facebook provides yet another example of using citizen-generated information ([**crowdsourcing**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/37_glossary.xhtml#gloss160)) in community health. [**Merchant and colleagues (2011)**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib30) described how mining data generated in social media can improve response to mass disasters by helping responders locate people who need help and identify areas where to send resources, build social capital, and promote community resilience postdisaster. “Tweets and photographs linked to timelines and interactive maps can tell a cohesive story about a recovering community’s capabilities and vulnerabilities in real time” (Merchant et al., p. 291). These authors caution, however, that social media should be used to augment—not replace—current disaster response and communication systems, as not all communications in social media are entirely trustworthy. In addition to utilizing social media posts, [**Benforado’s (2015)**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17-bib03) presentation to the EPA on Citizen Science and Crowdsourcing asked the question, “If you had 100,000 people to help you with your work, what would you do?” (slide 2). Enlisting and empowering people can promote volunteerism and advance science. There is power in investing in citizen science approaches and harnessing the efforts of volunteers.

**Summary**

Public health informatics strives to ensure that evolving health data systems will meet the data needs of all organizations interested in population health as national and international standards are developed for healthcare data collection. This includes standardization of environmental, sociocultural, economic, and other data that are relevant to public health. [**Table 17-1**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17_tbl1) provides the names, addresses, and URLs for important organizations dedicated to public health data and informatics. [**Table 17-2**](https://digitalbookshelf-jigsaw.southuniversity.edu/books/9781284142990/epub/EPUB/xhtml/26_Chapter17.xhtml#ch17_tbl2) lists abbreviations commonly used in PHI.

**Table 17-1** Important PHI Sites

| **Name** | **Address** | **Website** |
| --- | --- | --- |
| American Public Health Association | APHA, 800 I Street, NW Washington, DC 20001 | www.apha.org |
| Center for Public Health Informatics | CPHI, University of Washington, 1100 NE 45th Street, Ste 405, Seattle, WA 98105 | www.washington.edu/research/centers/256 |
| Centers for Disease Control and Prevention | CDC, 1600 Clifton Road, Atlanta, GA 30333 | www.cdc.gov |
| National Center for Public Health Informatics | NCPHI, 1600 Clifton Road, NE Mailstop E-78, Atlanta, GA 30333 | [**https://web.archive.org/web/20110123075557/**](https://web.archive.org/web/20110123075557/) [**http://www.cdc.gov/ncphi**](http://www.cdc.gov/ncphi) |
| Public Health Data Standards Consortium | c/o Johns Hopkins Bloomberg School of Public Health, 624 N Broadway, Room 325, Baltimore, MD 21205 | [**www.phdsc.org**](http://www.phdsc.org/) |
| Public Health Institute | PHI, 555 12th Street, 10th Floor, Oakland, CA 94607 | [**www.phi.org**](http://www.phi.org/) |

**Table 17-2** Abbreviations Used in PHI

| **BRFSS** | **Behavioral Risk Factor Surveillance System** |
| --- | --- |
| CDC | Centers for Disease Control and Prevention |
| CEPA | California Environmental Protection Agency |
| CPHI | Center for Public Health Informatics |
| CRA | Community Risk Assessment |
| EPI-X | Epidemic Information Exchange |
| HAN | Health Alert Network |
| IOM | Institute of Medicine |
| IT | Information Technology |
| NCPHI | National Center for Public Health Informatics |
| NEDSS | National Electronic Disease Surveillance System |
| NETSS | National Electronic Technology System for Surveillance |
| NHANES | National Health and Nutrition Examination Survey |
| NHIN | National Health Information Network |
| PH | Public Health |
| PHDSC | Public Health Data Standards Consortium |
| PHI | Public Health Informatics |
| PHIN | Public Health Information Network |
| PHRAP | Pennsylvania’s Health Risk Assessment Process |
| QRPH | Quality, Research, Public Health |
| RHIO | Regional Health Information Exchanges |
| SPRC | Suicide Prevention Community Assessment Tool |
| WONDER | Wide-ranging Online Data for Epidemiologic Research |
| YRBSS | Youth Risk Behavior Surveillance System |

The future of practice in public health depends on how efficiently and effectively public health data are captured, analyzed, and disseminated for regional, national, and global health planning and management. In an ideal world, we would see seamless data collection and sharing with a commitment to prevention and global health planning.

THOUGHT-PROVOKING QUESTIONS

1. Imagine that you are a public health informatics specialist and that you and your colleagues are concerned about a new strain of influenza. Which public health data are used to determine the need for a mass inoculation? Which data will be collected to determine the success of such a program?
2. What are the advantages and disadvantages of using crowdsourced social media data during a disaster response?

**References**

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