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FOCUS on Field Epidemiology

Public Health Surveillance Systems

CONTRIBUTORS

Author:

Meredith Anderson, MPH, CPH

Reviewers:

FOCUS Workgroup*

Production Editors:

Tara P. Rybka, MPH

Lorraine Alexander, DrPH

Rachel A. Wilfert, MD, MPH, CPH

Editor in chief:

Pia D.M. MacDonald, PhD, MPH, CPH

*** All members of the FOCUS Workgroup are named on the last page of this issue.**

UNC GILLINGS SCHOOL OF GLOBAL PUBLIC HEALTH

NORTH CAROLINA CENTER FOR PUBLIC HEALTH PREPAREDNESS

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The deadline for your annual public health surveillance report is quickly approaching. You have been asked to gather data from a variety of sources to provide a complete picture of the health of your community and compare it to the state and nation.

Where can you find all of this information? Luckily for you, public health surveillance data are being collected and tabulated all of the time. You just need to know where to look for the data.

In this issue of *FOCUS*, we discuss sources of surveillance data and provide examples of different types of surveillance systems. First, though, it is important to remember why surveillance data are collected.

Purpose of Surveillance

As noted in *FOCUS* Volume 5, Issue 5, collecting surveillance data has many purposes, including monitoring disease trends, detecting outbreaks, providing information to plan public health interventions, and stimulating research.

The specific uses of surveillance data vary depending on the organization or agency using the data. While national agencies are often interested in monitoring disease trends over time to inform public health policy, state and local agencies may have more immediate goals. Purposes of state and local surveillance include: assuring accurate diagnosis and treatment of infected persons, managing people exposed to disease, detecting outbreaks, and guiding public health prevention and control programs. (1)

Types of State and Local Surveillance Systems

A number of surveillance systems are used routinely by public health departments at local, state, and national levels. We will provide a broad overview of some of these systems, including vital statistics, disease reporting, and surveys, all of which can be used to monitor disease trends and plan public health programs for a wide variety of conditions.

Then we will discuss more specialized systems, including sentinel surveillance, zoonotic disease surveillance, adverse events surveillance, syndromic surveillance, disease registries, and laboratory surveillance. Some types of surveillance systems are more useful for certain diseases than others, but each fills a specific need.

Vital Statistics

Records of births and deaths are a basic but critical cornerstone of public health surveillance. Mortality data over the past century have shown a dramatic decrease in the rate of deaths due to infectious diseases, while the rate of death from non-infectious causes has remained steady. (2) The infant mortality rate (the number of deaths among infants

per 1,000 births) has long been used as an indicator of overall population health. Birth data are also used to monitor the incidence of preterm birth, a risk factor for a variety of adverse health outcomes.

In the United States, vital statistics are available from the National Center for Health Statistics and from state vital records offices. The Centers for Disease Control and Prevention (CDC) also operates an online system, CDC WONDER, containing data on births, deaths, and many diseases.

Disease Reporting (Morbidity Data)

One common form of surveillance involves the required reporting of certain diseases to public health authorities. Disease reporting is required internationally by the World Health Organization, through International Health Regulations (IHR). IHR require reporting of smallpox, wild-type poliomyelitis, severe acute respiratory syndrome (SARS), and human influenza caused by new subtypes. Under IHR, countries are also required to report any public health emergency of international concern. (3) A broad definition is used to capture any disease, condition, or event that could represent an international risk.

In the United States, disease reporting is mandated by state law, and the list of reportable diseases varies by state. States report nationally notifiable diseases to the CDC on a voluntary basis. (4) The list of notifiable diseases is updated regularly by the Council of State and Territorial Epidemiologists and the CDC.

Surveys

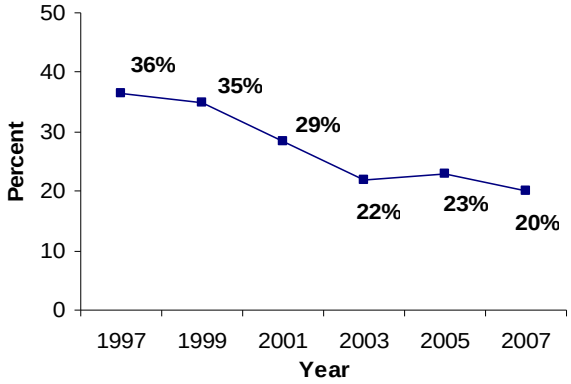
Routine surveys are surveillance tools that are especially useful for monitoring chronic diseases and health-related behaviors. One national survey conducted in the US is the Youth Risk Behavior Survey (YRBS). The YRBS asks high school students about health-related behaviors such as substance use, sexual behavior, physical activity, and nutrition. Results from the YRBS can be used to monitor trends in health behaviors, plan public health programs, and evaluate public health policies at national and state levels. For example, YRBS results have shown a decline in youth smoking from 36% in 1997 to 20% in 2007 (see Figure 1). (5)

Other national surveys conducted by the CDC include the Behavioral Risk Factor Surveillance System (BRFSS), the National Health Interview Survey (NHIS), the Pregnancy Risk Assessment Monitoring System (PRAMS), and the National Health and Nutrition Examination Survey (NHANES).

Sentinel Surveillance

An alternative to population-based surveillance, sentinel surveillance involves collecting data from a sample of reporting sites (sometimes called sentinel sites). For example, one of the most common sentinel surveillance systems used in the United States is for influenza. Selected health care providers report the number of cases of influenza-like illness to their state health department on a weekly basis. This allows states to monitor trends using a

Figure 1. Percent of high school students who reported smoking in the 30 days prior to the survey, United States, 1997-2007 (5)



Resources

National Vital Statistics System: Data on births, deaths, marriages, divorces, and fetal deaths from all 50 states, 2 cities (Washington, DC, and New York City) and 5 territories (Puerto Rico, the Virgin Islands, Guam, American Samoa, and the Commonwealth of the Northern Mariana Islands). Much of the information is available online. Web site: http://www.cdc.gov/nchs/nvss.htm

CDC WONDER: A user-friendly query system providing public health information on births, deaths, cancer incidence, HIV and AIDS, tuberculosis, vaccinations, and census data. Web site: http://wonder.cdc.gov/

Nationally Notifiable Infectious Diseases: List of diseases recommended for states to report to CDC. Web site: http://www.cdc.gov/ncphi/disss/nndss/phs/infdis.htm

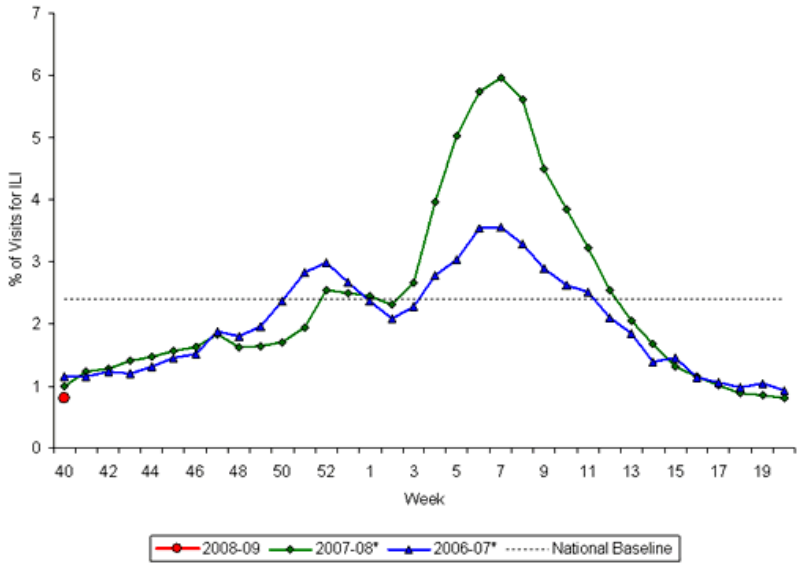
relatively small amount of information. Figure 2 shows the percentage of patients with influenza-like illness reported during the 2006-2007 and 2007-2008 influenza seasons. (6) The graph indicates that the peak of influenza activity during the 2007-2008 season occurred in late February and early March (Weeks 7-9).

Sentinel providers can also be used to gather more specific information. A sentinel provider network in British Columbia, Canada, was used in a study of vaccine effectiveness during the 2005-2006 influenza season. (7)

Zoonotic Disease Surveillance

Public health surveillance is not necessarily limited to humans. Surveillance of zoonotic diseases (diseases found in animals that can be transmitted to humans) often involves a system for detecting infected animals.

Figure 2. Percentage of visits for influenza-like illness reported by US sentinel provider network, 2006-2007, 2007-2008 (6)



In 2001, Florida conducted surveillance for West Nile Virus (WNV) using a variety of strategies, most involving animals. (8) The state health department provided a Web site and a telephone hotline for the public to report dead birds, some of which were collected and tested for WNV. Mosquitoes were collected and tested for WNV in 10 counties. Blood was collected from 3-12 sentinel chickens in each of 212 flocks up to 4 times per month and tested for antibodies to WNV. Veterinarians were asked to test horses with neurologic symptoms consistent with WNV. Health care providers were reminded of reporting and diagnostic criteria for possible human cases of WNV.

Together, these surveillance systems allowed public health authorities to determine the intensity of WNV by geographic area. Detection of WNV led to public health control measures, such as advising the public to protect against mosquito bites and intensifying mosquito abatement efforts.

Adverse Events Surveillance

One type of surveillance system focusing on patient safety is the Adverse Events Reporting System (AERS), operated by the Food and Drug Administration (FDA). (9) The purpose of this system is to gather information about negative effects experienced by people who have received approved drugs and other therapeutic agents. Voluntary reports to the AERS can come from health care providers, including physicians, pharmacists, and nurses, as well as members of the general public, such as patients or lawyers. Sometimes health care providers or patients may report adverse events directly to the product manufacturer. When this happens, the manufacturer is required to report the event to AERS. The FDA uses AERS to identify possible safety concerns associated with approved products.

Like AERS, the Vaccine Adverse Events Reporting System (VAERS) is focused on patient safety. VAERS, which is operated by the CDC with the FDA, operates like AERS, but focuses on negative effects experienced by people who have received licensed vaccines. (10)

VAERS was used in 2003 as part of a surveillance program for smallpox vaccines given to health care and public health professionals in preparation for a possible bioterrorist attack. More than 100 adverse events were reported after smallpox vaccination, including 16 suspect and 5 probable cases of myocarditis or pericarditis. (11) Based on these and related concerns, the Advisory Committee on Immunization Practices eventually recommended ending smallpox vaccination after health care and public health response teams had been vaccinated. (12)

Because AERS and VAERS are passive surveillance systems, they may be limited by underreporting or biased reporting, and they cannot be used to determine whether a drug or vaccine caused a specific adverse health event. (See *FOCUS* Volume 5, Issue 5 for definitions of active and passive surveillance.) Instead, these systems are used as early warning signals. Possible associations between drugs or vaccines and adverse events can then be

examined in more detail using a well designed epidemiologic study, and based on the results, appropriate action can be taken.

Syndromic Surveillance

Syndromic surveillance is a relatively new surveillance method that uses clinical information about disease signs and symptoms, before a diagnosis is made. Often, syndromic surveillance systems use electronic data from hospital emergency rooms.

For example, New York City operates a syndromic surveillance system using emergency department chief-complaint data from approximately 44 hospitals. (13) The data are monitored electronically for signals that might indicate the beginning of a disease outbreak. In 2002, the system detected a higher than usual number of diarrheal and vomiting symptoms. Based on this information, the health department notified hospital emergency departments of a possible outbreak and collected stool specimens, several of which tested positive for norovirus. Thus, the syndromic surveillance system provided the health department with early notification of the outbreak.

However, a similar outbreak later that year was not detected by the system. The failure to detect this outbreak was attributed to incorrect coding of the chief complaint by emergency departments.

The New York City experience illustrates the potential benefits of syndromic surveillance, as well as areas where changes are needed to increase the usefulness of the system.

Registries

Registries are a type of surveillance system used for particular conditions, such as cancer and birth defects. They are often established at a state level to collect information about persons diagnosed with the condition.

For example, cancer registries collect information about type of cancer, anatomic location, stage of disease at diagnosis, treatment, and outcomes. This information can be used to improve prevention programs. Based on registry data, a state might discover that women in rural areas are diagnosed with breast cancer later than women in urban areas. In this situation, the state might choose to promote mammography screening in rural areas using a mobile van.

Laboratory Data

Another source of surveillance data is public health laboratories, which routinely conduct tests for viruses, bacteria, and other pathogens. In the US, public health laboratories participate in the National *Salmonella* Surveillance System through electronic reporting of *Salmonella* isolates. In 2006, more than 40,000 isolates from the US were reported through this system. (14) Laboratory serotyping provides information about cases that are likely to be linked to a common source. For this reason, serotypes are useful for detecting local, state, or national outbreaks. (15)

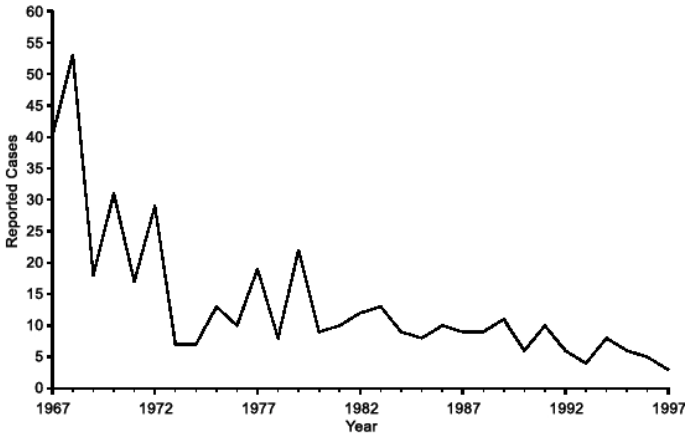
Another laboratory system that plays an important role in surveillance is PulseNet, developed by the CDC and the Association of Public Health Laboratories to monitor foodborne illness outbreaks. PulseNet enables public health laboratories across the US to compare pulsed-field gel electrophoresis (PFGE) patterns of bacteria isolated from ill persons and determine whether they are similar. This allows scientists to determine whether an outbreak is occurring, even at geographically distant locations, and can decrease the time required to identify outbreaks of foodborne illness and their causes. (16)

Public Health Actions Resulting From Surveillance

Now that we have discussed a variety of sources of surveillance data, you might be wondering how the data are actually used for public health action.

One global example is monitoring progress toward the eradication of poliomyelitis. Surveillance data allow us to see the dramatic decrease in paralytic poliomyelitis in the United States in the decades following the licensure of inactivated polio vaccine in 1955 and the oral polio vaccine in 1961 (see Figure 3). (17) Using similar data from countries around the world, the World Health Organization has implemented intensive vaccination programs in areas where the decline has not been as significant.

Figure 3. Number of cases of paralytic poliomyelitis by year, United States, 1967-1997 (17)



Surveillance for HIV/AIDS has been ongoing since the detection of the disease in the US in 1981. Data on the incidence and prevalence of HIV and AIDS among population subgroups and geographic areas are important to guide prevention and control efforts.

For example, between 2003 and 2006, the estimated number of HIV/AIDS cases increased among men who have sex with men while remaining steady among heterosexuals and decreasing among injection drug users. This information suggests that prevention programs may be working more effectively in some groups than others. Also, mapping HIV/AIDS rates for the United States shows a clear pattern of higher risk in the southeastern states than in the rest of the nation (see Figure 4). This suggests a need for more prevention measures in the southeast.

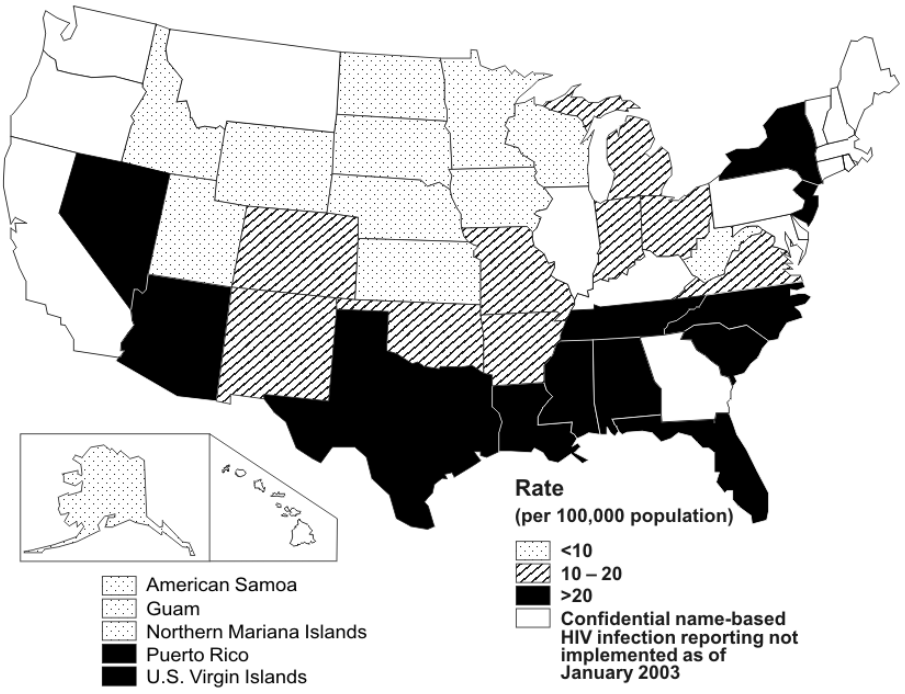
Recent improvements in HIV testing will soon allow public health professionals to distinguish between recent and older infections at the population level, providing a better estimate of HIV incidence. (18)

Conclusion

There are many sources of public health surveillance data at local, state, and national levels. This issue highlights a few common sources, but there are a variety of others. Knowing where to look for different types of data can save valuable time and resources.

Surveillance data can be used for a variety of purposes, including guiding prevention strategies and targeting resources, detecting disease outbreaks of local, national, and international significance, and evaluating public health control measures.

Figure 4. Rates of diagnosed HIV/AIDS, by area of residence, United States, 2006 (18)



CONTACT US:

The North Carolina Center for Public Health Preparedness
The University of North Carolina at Chapel Hill
Campus Box 8165
Chapel Hill, NC 27599-8165

Phone: 919-843-5561
Fax: 919-843-5563
Email: nccphp@unc.edu

REFERENCES:

1. Birkhead GS, Maylahn CM. State and local public health surveillance. In: Teutsch SM, Churchill RE, eds. *Principles and Practice of Public Health Surveillance*. 2nd ed. New York, NY: Oxford University Press; 2000:253-286.
2. Armstrong GL, Conn LA, Pinner RW. Trends in infectious disease mortality in the United States during the 20th century. *JAMA*. 1999;281(1):61-66.
3. World Health Organization. International health regulations (2005). 2nd ed. http://www.who.int/csr/ihr/en/. Published 2008. Accessed October 3, 2008.
4. Centers for Disease Control and Prevention. Summary of notifiable diseases – United States, 2006. *Morb Mortal Wkly Rep.* 2008;55(53):1-84.
5. Centers for Disease Control and Prevention. Cigarette use among high school students – United States, 1991-2007. *Morb Mortal Wkly Rep*. 2008;57 (25):689-691.
6. FluView. Outpatient illness surveillance. Centers for Disease Control and Prevention Web site. http://www.cdc.gov/flu/weekly/. Updated October 10, 2008. Accessed October 14, 2008.
7. Skowronski DM, Masaro C, Kwindt TL, et al. Estimating vaccine effectiveness against laboratory-confirmed influenza using a sentinel physician network: results from the 2005-2006 season of dual A and B mismatch in Canada. *Vaccine*. 2007;25(15):2842-2851.
8. Blackmore CGM, Stark LM, Jeter WC, Oliveri RL, Brooks RG, Conti LA, Wiersma ST. Surveillance results from the first west nile virus transmission season in Florida, 2001. *Am J Trop Med Hyg*. 2003;69(2):141-150.
9. Food and Drug Administration, Center for Drug Evaluation and Research. Adverse Event Reporting System (AERS) Web site. http://www.fda.gov/cder/aers/default.htm. Published August 7, 2002. Updated September 5, 2008. Accessed November 21, 2008.
10. Zhou W, Pool V, Iskander JK, et al. Surveillance for safety after immunization: vaccine adverse events reporting system (VAERS) – United States, 1991-2001. *MMWR CDC Surveill Summ*. 2003;52(SS-1):1-11.
11. Centers for Disease Control and Prevention. Update: adverse events following civilian smallpox vaccination – United States, 2003. *Morb Mortal Wkly Rep.* 2004;53(5):106-107.
12. Centers for Disease Control and Prevention. Advisory Committee on Immunization Practices (ACIP) statement on smallpox preparedness and vaccination. http://www.bt.cdc.gov/agent/smallpox/vaccination/acipjun2003.asp. Published June 18, 2003. Accessed October 23, 2008.
13. Steiner-Sichel L, Greenko J, Heffernan R, Layton M, Weiss D. Field investigations of emergency department syndromic surveillance signals – New York City. *Morb Mortal Wkly Rep*. 2004;53(suppl):190-195.
14. Centers for Disease Control and Prevention. *Salmonella* surveillance: annual summary, 2006. http://www.cdc.gov/ncidod/dbmd/phlisdata/salmonella.htm. Published 2008. Accessed October 14, 2008.
15. Swaminathan B, Barrett TJ, Fields P. Surveillance for human *salmonella* infections in the United States. *J AOAC Int.* 2006;89(2):553-559.
16. Centers for Disease Control and Prevention. What is PulseNet? PulseNet Web site. http://www.cdc.gov/pulsenet/whatis.htm. Published July 24, 2006. Accessed December 3, 2008.
17. Centers for Disease Control and Prevention. Summary of notifiable diseases, United States, 1997. *Morb Mortal Wkly Rep.* 1998;46(54):1-87.
18. Centers for Disease Control and Prevention. *HIV/AIDS Surveillance Report, 2006*. Vol. 18. http://www.cdc.gov/hiv/topics/surveillance/resources/reports/. Published 2008. Accessed October 14, 2008.

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