CHAPTER 2

Public Health Surveillance

Philip S. Brachman

1. Introduction

The term *surveillance*, derived from the French word meaning "to watch over," may be defined as a system providing close observation of all aspects of the occurrence and distribution of a given disease through the systematic collection, tabulation, analysis, and dissemination of all relevant data pertaining to that disease.[1] The preferred term is *public health surveillance*, which emphasizes the focus of surveillance as discussed in this chapter to develop data that results in a public health preventive act ion. This distinguishes public health surveillance from other types of surveillance.[2] Although the methodology of surveillance is basically descriptive, its function is more than merely collective and archival. Surveillance must be dynamic, current, purposeful, and result in a public health action. This action frequently results in the establishment of a new or the reinforcement of an existing public health policy. It is fundamental for the prompt and effective control and prevention of disease. Traditionally, surveillance was first applied to the acute communicable diseases in the mid-1800s.[3] Since then, surveillance methodologies have been utilized to cover a many infectious diseases,[1] a wide variety of non-infectious diseases, and other health-related events such as environmental hazards, potential bioterrorism events injuries, vaccinations, the distribution of biological products, and health-care delivery.

2. History

William Farr, of the General Registrar's Office of England and Wales, is credited with initiating disease surveillance in the mid-1800s though mortality and some morbidity data were being collected during previous years in communities in other countries. He collected, collated, and analyzed vital statistical data and distributed reports to appropriate health personnel as well as to the public.[3] In the United States, the collection of national morbidity data was initiated in 1878, when Congress authorized the Public Health Service (PHS) to collect reports of the occurrence of the quarantinable diseases, namely, cholera, plague, smallpox, and yellow fever. In 1893, Congress passed an act stating that weekly health information should be collected from all state and municipal authorities. In 1902, in an attempt to develop uniformity, the Surgeon General of the PHS was directed to provide forms for collecting, compiling, and publishing surveillance data. In 1913, the state and territorial health authorities recommended that every state send weekly telegraphic summaries reporting the occurrence of selected diseases to the PHS. All states were reporting the occurrences of diseases by 1925. In 1949, when the National Office of Vital Statistics (NOVS) was established in the PHS, the communicable-disease-reporting function (morbidity reporting) was merged with the national mortality registration and reporting functions that were the primary responsibility of the NOVS. Until the early 1950s, the communicable disease reports were published weekly in the official journal *Public Health Reports*. When this journal became a monthly publication, the NOVS issued a separate weekly bulletin, the *Morbidity and Mortality Weekly Report* (MMWR), that was distributed to state health officers, state epidemiologists, county and city health officers, and others including persons who requested its receipt. In January 1961, the responsibility for receiving morbidity reports from the states and larger cities and issuing of the MMWR was transferred from Washington, DC, to the Communicable Disease Center [now called the Centers for Disease Control and Prevention (CDC)] in Atlanta, Georgia.

Philip S. Brachman • School of Public Health, Emory University, Atlanta, Georgia, 30322, USA

A.S. Evans, P.S. Brachman (eds.), *Bacterial Infections of Humans*, DOI 10.1007/978-0-387-09843-2_2,

In the United States, the application of the term *surveillance* to the watchfulness over a nationally important communicable disease (malaria) was begun in 1946 by the CDC[4] in part to monitor veterans who were returning from endemic areas. The benefit of applying a specific case definition and a critical epidemiological evaluation to the former rather than crude resulted in the recognition that malaria had ceased to be an indigenous disease. Endemic spread of infection had ceased some years before through control of the vector.

In 1955, following the initial introduction of the Salk, killed poliomyelitis vaccine, an epidemic of vaccine-associated poliomyelitis occurred ("Cutter Incedent"). The case was traced to one manufacturer's faulty manufacturing process. Subsequently, national surveillance of poliomyelitis was ordered by the Surgeon General as an essential step toward a solution for this national disaster.[5] In 1957, influenza was placed under surveillance in anticipation of the impending pandemic of Asian influenza for which a comprehensive national program of widespread vaccination and education of doctors and preparation of hospitals to meet such a possible disaster was undertaken by the Surgeon General. The influenza surveillance program has continued, and one of its essential functions is to provide information to guide manufacturers in the preparation of influenza vaccine as concerns its antigenic composition and the amount of vaccine to produce. In 1961, because of the increasing public health concern with salmonellosis, a special *Salmonella* surveillance program was developed in conjunction with the states to better define the problem so that appropriate control and prevention measures could be instituted. In recent years, surveillance has been extended to HIV, Lyme Disease, West Nile virus infection, SARS, avian influenza and many other public health illnesses or conditions.

The CDC has published a series of reports that further define public health surveillance. These include an outline of a comprehensive program,[6] "Guidelines for Evaluating Surveillance Systems,"[7] and "Case Definitions for Public Health Surveillance."[8] Responding to the reality of new emerging infections and reemerging infections, a number of surveillance systems have been implemented to define these diseases supported by CDC and other groups. Responding to reality, new surveillance systems are being developed and evaluated related to public health preparedness for noting as early as possible natural and man made disasters. There are several textbooks that have been published on public health surveillance (see Suggested Readings).

At present, the occurrence of 59 diseases is reported weekly and that of 7 other diseases are reported annually by state health departments to the CDC. Seven additional diseases are reported by either special case-reporting forms or line-listing forms submitted either monthly or annually. These reports are published in the MMWR and are summarized annually in the *MMWR Annual Summary*.[10] These lists are reviewed annually by the state and territorial epidemiologists and modified as indicated by the changing nature of the diseases and the occurrence of new diseases. Additionally, more intensive surveillance is maintained over selected diseases by means of special surveillance efforts to develop more specific data concerning these diseases. Selected non-infectious diseases are also under surveillance, such as birth defects, non infectious injuries, and diabetes mellitus.

National disease surveillance programs are maintained by most countries in the world. The methods used to report cases, the diseases to be reported, the analyses, and the type and frequency of reports vary, but the value and importance of surveillance is universally recognized. A number of European countries have been working to improve national surveillance programs and develop an European reporting system.[11] Desenclos has discussed various methods for collecting surveillance data.[12] The World Health Organization (WHO) maintains surveillance on the quarantinable diseases (cholera, plague, and yellow fever) as well as other selected diseases. The most recent disease to come under worldwide surveillance is acquired immunodeficiency syndrome (AIDS). WHO prepares weekly reports as well as other reports summarizing these data. WHO also responds to worldwide disease problems by developing special surveillance programs for emerging infections (i.e., Nipal virus, SARS) or for potential pandemic diseases (i.e., avain influenza).

3. Use of Surveillance

A surveillance program can be designed to produce a variety of output data depending on the purpose of the program. It can portray the natural history of the disease, including a description of the occurrence of the disease by time, place, and person. Surveillance data should describe the background (sporadic, endemic, or ongoing) level of the disease, as well as changes in the occurrence of the disease as modified by nonrecurring events such as epidemics. Surveillance can be used to monitor changes in the agent, such as antibiotic resistance in gonococci, staphylococci, pneumococci, and *Mycobacterium tuberculosis*, or changes in virulence, or genetic changes.

Analysis of surveillance data can help to establish priorities for developing a disease-specific control and/or a prevention program. Surveillance can also be used to confirm a hypothesis about the occurrence or distribution of

disease or indicate the need for further study or additional data. Analysis of surveillance data can lead to the development and/or institution of control and/or prevention measures such as chemotherapy, chemoprophylaxis, new resources or resource allocation (e.g., people, equipment, or monies), or additional training for persons involved in control and prevention activities. Surveillance can be used to evaluate the effectiveness of newly instituted control and/or prevention measures. Surveillance data are also important in forecasting or predicting the future pattern of the occurrence of a disease.

In this chapter, surveillance is discussed primarily as it involves bacterial infectious diseases. Surveillance techniques for other infectious diseases are similar, though there may be some variation in the data collection procedures.

4. Data Sources

The WHO in 1968 codified the term *surveillance* on a truly global basis.[13] Ten "elements" or distinguishable sources of data were identified Any one or any combination of the ten can be used to support a disease-specific surveillance program. The sources used to develop the surveillance data depend on the disease itself, the methods used for identifying the disease, the goals of the program, the personnel and material resources available, the population involved, and the characteristics of the disease's occurrence. One source of data can be used regularly and other methods utilized as necessary to improve the sensitivity and/or specificity of the data depicting the occurrence of the disease.

4.1. Mortality Data

Mortality registration has been used the longest, but it is useful only for diseases that are associated with fatalities. If the case-fatality ratio is too low, mortality statistics may not provide an accurate assessment of the occurrence of the disease. If mortality rate data are accurate and if the proportion of deaths to cases is known from past studies, then the number of deaths can provide an estimate of the actual number of cases that have occurred and define the pattern of disease occurrence over time.

Unfortunately, there is wide variation in the accuracy with which death certificates are filled out. Diagnoses are not defined consistently and diseases under surveillance may not be recorded even if they were a contributory cause of death, Also, there is a time lag in reporting deaths, so that a surveillance program based on mortality registration has an inherent delay of from weeks to months. In general, information derived from analyses of the cause of death on death certificates is inconsistent and likely inaccurate.

An example of the use of mortality data for surveillance is the collection of pneumonia and influenza weekly mortality reports from 122 American cities.[14] These data are used to describe weekly pneumonia and influenza activity and help determine the burden and geographic distribution of disease. Another example occurred in the 1960s during an investigation of shigellosis in rural areas in Central America where there was no ongoing surveillance program.[15] The only available reports of any of the cases were listings of deaths that were routinely noted in "vital statistics" books maintained in the communities. By noting the recording of deaths and by knowing the case-fatality ratio, it was possible to develop information concerning the occurrence of cases of shigellosis.

4.2. Morbidity Data

The second, and most commonly used, source of surveillance data is morbidity or case reporting. This is a prompt, simple, and useful system that is dependent on the reporting of cases of the diseases under surveillance. Reporting the occurrence of disease is the responsibility of the patient's health-care professional, usually a physician. He or she may delegate this responsibility to someone else such as a nurse, clerk, or administrator. Cases may be reported by the responsible person calling the health department or vice versa, or they may be reported each day or each week on a special form sent by mail or fax. Computers are also increasingly being used to report cases at all levels of reporting. Alternatively certain diseases lend themselves to mandatory reporting of laboratory results by laboratories, if the disease under surveillance requires a laboratory test for diagnosis. The techniques of reporting are described in greater detail in Section 6.

4.3. Individual Case Reports

Individual case investigation is more likely to be performed with rare diseases or unusual cases of a common disease. For diseases of high frequency, investigating individual cases is usually neither practical nor necessary, but may be conducted in order to obtain more specific case data or as a check on the validity of morbidity or mortality reporting. As a disease decreases in incidence, individual case investigation may be of increasing importance to determine why the case occurred and to further direct control and prevention measures. As the occurrence of a disease decreases, leading toward prevention, elimination, or eradication status, then intensive investigation of each reported case is important. The value of this approach was dramatically demonstrated

in the smallpox eradication program[13] and is currently being practiced in the international poliomyelitis eradication program.[16] Additionally, as measles immunization activities are being intensified in the United States, individual case reporting is being emphasized.[17]

4.4. Epidemic Reporting

The fourth source of surveillance data is the reporting of epidemics. Frequently, there is quantitative improvement of reporting when clusters of cases occur. Thus, single cases of shigellosis or salmonellosis may not be individually reported, but if there is an epidemic, then all cases that are part of the epidemic may be reported.

4.5. Epidemic Field Investigation

Epidemic field investigations may uncover more cases of the disease than would have been reported without the investigation. In the epidemic of salmonellosis in Riverside, California, in 1965, several hundred cases were initially reported; however, following a field investigation, 16,000 cases were estimated to have occurred.[18] In 1987, an epidemic of *Salmonella typhimurium* gastroenteritis occurred in Chicago, Illinois, related to pasteurized milk and 16,000 cases were cultured positive for the organism. However, community surveys suggested that between 170,000 and 200,000 cases occurred.[19] In 1993, cases of cryptosporidiosis were reported from Milwaukee, Wisconsin. Contaminated, inadequately purified city water was shown to be the source of infections. Subsequently, investigations suggested that more than 400,000 cases had occurred. The decision to investigate an epidemic will be based on the specific disease, the seriousness of the outbreak, the extent of the problem, the anticipated need for more specific information concerning the occurrence of the epidemic, availability of resources, research potential, and possibly political pressures.

4.6. Laboratory Reporting

The laboratory is essential in identifying and confirming pathogens. Although many diseases can be adequately described clinically, there are others for which laboratory identification of the etiologic agent is essential for accuracy. For example, gastroenteritis may be caused by various organisms; but it is frequently not possible to be certain of the etiology on the basis of clinical and epidemiological data alone. Thus it is necessary to perform laboratory testing to identify the etiologic agent. The accuracy of the *Salmonella* and *Shigella* surveillance programs in the United States depends on laboratory testing. Every state now has laws that identification of agents of reportable infectious diseases must be reported to the local health authorities.

In addition to disease identification, the laboratory can also provide important information concerning specific characteristics of microorganisms that are epidemiologically important. For example, the antigenic characteristics of influenza strains are important, since significant changes in the prevalent strain will necessitate changes in formulation of vaccine to be used before the next influenza season. An example is the surveillance of avian influenza strains isolated from avians and humans to identify genetic changes that will increase the likelihood of human-to-human transmission. Identifying the serotype of salmonellae isolated from different patients may be necessary in order to associate different isolates as part of a single epidemic and to identify the source of infection. Careful attention to antibiotic sensitivity patterns can indicate a change in the epidemiological pattern of the disease or may be a forewarning of an impending upsurge in the occurrence of the disease. This has been seen in the increasing frequency with which antibiotic-resistant gonococci are being identified,[20] the spread of methicillin-resistant *Staphylococcus aureus*[21] within and between hospitals, and the increasing identification of vancomycin-resistant enterococci as well as of multiresistant *M. tuberculosis* (see Chapters 15, 33, 25, and 39). A variety of molecular tools are now available that provide highly specific identification of a strain or substrain of an organism. Methods for both phenotyping and genotyping are now used. Techniques such as the polymerase chain reaction (PCR), genome sequencing, immunoblot electrophoresis, and a variety of DNA and RNA probes have given high sensitivity and high specificity to the detection of organisms in various tissues and to the precise identification of the particular strain causing a given epidemic. Highly specific antibody identification is also now possible through commercially available monoclonal antibodies. New emerging technologies, such as proteonics and others, are adding to our ability to further identify pathogens (see Chapter 3). These techniques make it possible to follow the spread of an organism in an epidemic and to differentiate between exogenous reinfection and endogenous reactivation.

The serology laboratory also contributes to surveillance by identifying and/or confirming the presence of a specific disease. Usually, two serum specimens are obtained from each individual, one during the acute phase and one during the convalescent phase of illness, to demonstrate a significant change (usually fourfold) in titer. However, if only a single serum specimen is obtained, the occurrence of a specific disease may be suggested if the antibody titer to that disease is

elevated beyond a certain value or by the presence of IgM antibody. Also, if elevated titers are found in serum specimens from a group of patients who had similar illnesses, then these single specimens can be of assistance in making the diagnosis (see Chapter 1).

4.7. Hospital Reporting

The reporting of infectious diseases among hospitalized patients, previously hospitalized patients, or outpatients is a valuable and important source of information. These infections may be truly hospital acquired (nosocomial) or community acquired (see Chapter 26). Community-acquired infections among patients admitted to a hospital reflect the occurrence of infectious diseases in the community. Infections that develop among hospitalized patients or outpatients may represent an endogenous or a exogenous source of infection. If exogenous, the source may be another patient, hospital employee, rarely a visitor, or the hospital environment. An exogenous source may reflect a community problem. Endogenous infections reflect organisms from the patient who may have become colonized from a community source. Computerized administrative data systems can strengthen the hospital surveillance program (see Chapter 26).

4.8. Surveys

Surveys can provide information concerning the prevalence of disease. Clinical surveys may include questions related to the occurrence of a disease, physical examination such as spleen surveys to identify patients with malaria, or diagnostic tests such as skin tests to determine the prevalence of histoplasmosis or tuberculosis. In some countries, blood smear surveys may be used in surveillance for malaria. Other types of surveys include household surveys, such as the National Health Interview Survey, which includes 55,000 households surveyed annually; cluster surveys, such as are used in evaluating immunization programs; and telephone surveys, which can be used to estimate the magnitude of an outbreak of a disease.

Serological tests for certain bacterial, rickettsial, and treponemal infections carried out on a representative sample of a population can provide prevalence data for different age, sex, and geographic segments of the group tested. Incidence data can be obtained by demonstrating the appearance or rise in antibody titer to a given infection in two serum specimens spaced in time such as the start and end of an epidemic, military service, or a college year; the occurrence of recent infection can also be demonstrated in a single specimen by determining the presence of specific IgM antibody for that infectious agent or antibody reflecting early infection. The uses of seroepidemiology are presented in more detail in the companion book on viral infections.[22]

4.9. Animal Reservoir and Vector Distribution

Animal reservoir and vector distribution studies are important in maintaining surveillance of zoonotic and arthropod-borne diseases. Information about rabies in animal reservoirs in a specific geographic area has been and remains important in making a decision concerning the need to treat a human exposed to an unidentified animal. The knowledge that tularemia is occurring in animals or that ticks infected with *Francisella tularensis* are present in an area would support reports of suspect cases of tularemia in humans. Similar studies are in progress to define the distribution of Lyme disease, which is caused by *Borrelia burgdorferi* whose vector is one of several Ixodid ticks. Knowledge about the occurrence of plague in prairie dogs or rodents can be important in evaluating data concerning possible cases of human plague. Surveillance of animal rabies is important as a warning system for the potential occurrence of human rabies. Monitoring the occurrence of avian influenza in birds has been important as concerns the development of influenza in humans due to infections with the avian influenza virus.

4.10. Biologics and Drug Distribution

The utilization of biologics and drugs for treatment or prophylaxis of a disease may be used to monitor disease occurrence. For example, in an outbreak of diarrheal disease, the increasing sales of antidiarrhea medications by pharmacies serve to corroborate the occurrence of disease as occurred in the epidemic of cryptosporidiosis in Milwaukee in 1993.[22A] Similarly, an increase in requests for immune serum globulin can be a clue to the occurrence of cases of hepatitis A.

4.11. Demographic and Environmental Data

Demographic and environmental data are necessary to analyze disease occurrence data effectively. Such data may include age, sex, occupation, residence, or other personal information. Incidence rates cannot be determined until denominator data concerning the population are available. For example, when an increase in the number of isolations of *Salmonella eastbourne* was noted, an analysis of cases by age showed a significant number of cases among young children.[23] This fact was an important clue in leading the investigators to identify chocolate candy as the vehicle of

infection. The ability of new molecular and electrophoretic techniques to identify the specific strain of organisms such as *Salmonella* has allowed epidemics in different geographic areas to be interlinked and a common commercial source identified.[24] The problem of multiple drug resistant tuberculosis in New York City prisons is an example of antibiotic sensitive testing showing the relationship of these cases that occurred in a number of prisons (see Chapter 40).

4.12. News Media

Another useful source of surveillance information is public information gathered through the news media. It is not uncommon for the occurrence of a disease, and especially an epidemic, to be first noted by the news media. Additionally, the news media can perform an important role in alerting the public to the occurrence of a disease epidemic, and thus stimulate the reporting of cases that otherwise might not have been diagnosed or reported. In an epidemic of botulism associated with a restaurant in a western state, radio reports alerted a patron of the restaurant to the possibility of exposure after the patron had returned to his home several hundred miles from the restaurant.[25] At the time he heard the radio report, he was experiencing some symptoms. Accordingly, he sought medical assistance, botulism was diagnosed, he was successfully treated, and another case was reported. The national epidemics of *Escherichia coli* 0,157:H7 in spinach and salmonella in peanut butter are other examples of the media in surveillance.[25A,25B]

5. Routine Surveillance

As previously indicated, routine surveillance of a specific disease will not include all the data sources discussed above. The methods that provide the most accurate information collected in a practical and efficient manner that satisfies the objectives of the surveillance program should be utilized. If more information is needed concerning occurrence of the disease, then additional sources of information can be incorporated into the surveillance system.

The need for completeness of reporting varies according to the incidence of the disease under surveillance. For those diseases that either normally do not occur in an area or occur at a very low incidence, it is essential, for control purposes, that all cases be reported. Examples (in the United States) include plague, yellow fever, poliomyelitis, human rabies, measles, hanta virus disease, avain influenza, and agents of boterrorism.

On the other hand, to maintain surveillance on diseases that commonly occur, it is not critical for all cases to be reported. In the United States, it is estimated that only 1% of cases of salmonellosis, for example, and 15–20% of cases of viral hepatitis are reported. The fact that all cases are not reported should not reduce the effectiveness of surveillance, since it is generally the trends and patterns of disease occurrence that are important in the detection of problems and implementation of control and prevention measures. Changes in the trend should reflect real changes in the occurrence of disease and not changes reflecting a variation in the methods of surveillance. If the methods of obtaining the surveillance data have not changed significantly during a period of time, the case definition has not changed, and the data collected are a representative sampling of the cases that have occurred, then these data should be suitable for determining the trend of the disease. However, a change in the methods used to collect the surveillance data, followed by a change in the reported occurrence of the disease, may be falsely interpreted as a change in the incidence of the disease. An example of this artifact could have occurred in the national *Shigella* surveillance program that was initiated in 1964, with routine reporting from 17 states. Several years later, the remaining states began reporting their isolates; the sudden increase in reported cases could have been misinterpreted if attention had not been given to the mechanics of the surveillance program.[26] Similar artifacts in surveillance data have occurred in the national AIDS surveillance program. As the definition of a case of AIDS has been modified to accommodate new knowledge concerning the clinical manifestations of the disease, the overall surveillance data have reflected these changes.[27]

Case reporting of certain diseases may be discontinued because effective control measures are not available. One such example is streptococcal infections, which may give the uninformed the wrong idea that these infections are no longer of importance.

To validate surveillance data, various methods have been used. These include (1) active surveillance, that is, physicians in the reporting area can be called and asked if they reported all cases of the disease among the patients within a specific time period; (2) hospital records can be checked by means of a prevalence study to see that all notifiable diseases have been reported; and (3) laboratory reports from hospital and public health laboratories for a given disease can be compared to the cases reported to the health department.

6. Reporting

In general, detailed individual case data are not necessarily useful in surveillance programs. It is the analysis of

collective data that provides meaningful information. If more specific case information is necessary, then individual cases can be traced back and additional data obtained.

The quality of a surveillance program is as good as the quality of the data collected. In morbidity reporting, an integral component is the person who has the responsibility for reporting the occurrence of the disease. Most frequently, this is the person who has medical responsibility for the patient, and usually that person is a physician. This responsibility may be delegated to someone else, such as the physician's nurse or, in a hospital, infection control practitioner, the house staff or the administrator. The increasing use of computers by hospitals and large health maintenance organizations (HMOs) for recording diagnoses and the development of linkage systems for such data provide new means of collecting and evaluating surveillance data. In reporting cases of any disease by any means, confidentiality of the patient must be respected and maintained. The Health Insurance Portability and Accountability Act (HIPPA) law concerning patient confidentiality does allow the reporting of patient data but emphasizes the need to maintain confidentiality of the patient (Ref).

In the United States, every state has a law indicating the occurrence of which diseases must be reported and the mechanism of how they should be reported and to whom. Additionally, there usually is a penalty assessed, a monetary fine, prison time, or demerit system that will prohibit renewal of medical license of a reportable case is not reported. However, it is not apparent that any penalty has ever been assessed. The reporting from the States to CDC is a voluntary system and as previously stated the diseases to be so reported are discussed and subject to be modified each year as discussions between the CDC and the state epidemiologist. Within a community, cases are reported to the local health authority, such as a city health department. At regular intervals, usually weekly, these cases will be reported to the state health department. In the United States, the weekly totals and selected individual case data will be reported to the CDC. Many local health departments report to the state health department by computer. All state health departments report their data to the CDC via computers. The development of worldwide systems of communication such as the Internet and World Wide Web has yielded a global method of making such data widely available. The MMWR and the *WHO Weekly Record* are available in these systems. Computer reporting by health-care physicians has been initiated in France[29] and in China.[30]

6.1. Motivation

The diligence with which cases are reported reflects the motivation of the person responsible for reporting. Physicians frequently do not wish to assume this responsibility because of the constraints on their time and the low priority they give to reporting. Also, they may not be aware of state law that mandate reporting of specific diseases. They may not know how to report. There needs to be some motivation developed for reporting other than that related to disease-reporting laws. Motivation may result from being a participant in a public health project or from professional or personal gain. A report summarizing the surveillance data (see Section 9) may be motivational (as well as educational), so that the reporter does recognize that some action results from disease reporting. Motivation may also be derived from knowledge that surveillance data can support the development of effective control and prevention programs, with a decreased incidence in the occurrence of disease.

Reporting may be stimulated by the availability of an epidemiologist to provide assistance to the reporting physician on request. Another source of motivation may be that the reporting of surveillance data results in important clinical and therapeutic data being made available to the practitioner. For example, the increase in antibiotic-resistant strains of *Neisseria* gonococci reported through the CDC's surveillance program is important information for practicing physicians to have when they see a patient, make a clinical diagnosis of gonorrhea, and want to initiate therapy immediately. Another example is the increasing number of reports of antibiotic-resistant *Mycobacterium tuberculosis*, which is a significant problem to clinicians as well as to public health professionals. Also, the worldwide problem of resistant strains of the pneumococcus has been another serious situation as is the problem of the increasing number of reports of community-acquired multiple-resistant *Staphylococcus aureus* (MRSA) (see Chapter 34), the increasing resistance of Neissaria gonorrhea (see Chapter 16). These examples of the application of surveillance data to the practice of medicine can serve to motivate physicians to participate in surveillance activities. Disease reporting can also be stimulated by making specific therapeutic drugs available to the physician on notification of the occurrence of a specific disease. In some communities, reports of hepatitis A result in serum immune globulin being made available for prophylactic use. A report of a case of botulism may lead public health authorities to make botulinum antitoxin available. Reports of certain tropical parasitic diseases make it possible for physicians to obtain certain therapeutic drugs from the CDC not otherwise available. The availability of a drug exclusively from the CDC in the early 1980s to treat cases of *Pneumocystis carinii* pneumonia led to recognition of a new disease, AIDS, in 1981.[31]

A reward system for reporting can be used. The reward can be publicity given to the reporting physicians by listing their names in the surveillance report or in a scientific paper

summarizing the surveillance data. A monetary reward system has also been tried, with an annual payment or a specific amount of money being given for each report submitted. This activity was not very successful, however, and is no longer being practiced.

Health officials must recognize the negative effect of a reporting mechanism that is too complex or that demands excessive expenditure of time on the part of the reporter. If reporting of cases brings adverse publicity to the patient, physician, hospital, or community, surveillance will be inhibited. Adverse publicity that leads to a loss of money or to legal action against the reporter or hospital also has a negative effect on the reporting of disease. Some countries choose not to report quarantinable diseases to the WHO because of the knowledge that publicity concerning the occurrence of those diseases may have an adverse effect on the movement of people and goods across their borders.

6.2. Ease of Reporting

To stimulate reporting, the mechanisms must be simple and yet compatible with an effective and sensitive surveillance system. There must be a relatively easy mechanism by which cases can be reported to the public health authorities. However, the information being requested must provide adequate data for developing a meaningful and practical control and prevention program. It is important to request only data that meet the objectives of the surveillance program. If superfluous data are requested and collected but not used, the reporter will question the surveillance effort and support for the program will decline.

Reporting from the health-care practitioner to the local health department could be simplified to the extent that when the diagnosis of a reportable disease is made and entered into the health-care providers' computer that can be programmed to automatically report the case to the local health department. Only the patients' data that should be reported would be provided to the local health department. Additionally, the local health department's computer can be programmed to report the reportable diseases, either in singularly or in batches, to the next level of reporting (regional, district, and/or state). Thus, all reporting from the health-care provider (or laboratory) to CDC can be accomplished by computers.

6.3. Case Definition

It is important in developing a surveillance program that *specific* case definitions be developed and publicized so that those persons participating can accurately report cases. The definition must be simple, acceptable, and understandable and not incorporate diagnostic criteria that are difficult to comprehend. If laboratory test results are part of the definition, the test must be readily available and inexpensive and not demand a great deal of the patient. It is also important to consider whether only confirmed cases should be reported or whether reporting should also include cases that are less definite as cases of the specific disease and are classified as presumptive or suspect cases of the disease; if so, the definitions of these categories must be acceptable and publicized. The CDC has developed and published a compilation of case definitions for public health surveillance that standardizes definitions for all the diseases reportable in the United States.[8]

6.4. Passive Reporting

Surveillance reporting may be passive or active. Passive surveillance is the routine reporting in which case reports are initiated by the health care provider. Preprinted postcards or reporting forms and stamped envelopes routinely supplied to the reporter can be used to report the requested surveillance data. These cards can be mailed individually or at weekly or monthly intervals, summarizing all cases seen during that time interval; negative reports, i.e., the lack of occurrence of cases, can also be requested. Some states divide the reportable diseases into those commonly seen and those only rarely seen. The reporting official is asked to provide a negative report if no cases of the common diseases are seen and to fill out the form for a rare disease only when a case is actually seen. The reporting form can be a general form suitable for a number of diseases or a specific form used only for a single disease. Special forms can be developed if more detailed data are desired.

Reporting to the local public health office may be done by telephone. The report may be taken by a clerk during working hours or tape-recorded if phoned in outside working hours. The tape recording can be subsequently transcribed by a clerk, who can call the physician if more data are required. To stimulate reporting from throughout an area such as an entire state, a toll-free telephone system can be established. It has been demonstrated that the availability of an automatic telephone-answering service for use at any time has stimulated reporting of disease by physicians. Passive reporting can be improved as health-care providers better utilize personal computers in their practice. This could stimulate better and more rapid reporting and decrease the error rate due to mishandling data.

6.5. Active Reporting

An active surveillance system can be instituted to improve the opportunities to obtain surveillance data; it can

be used for routine surveillance or be an integral part of a special surveillance program established to monitor a specific disease such as during an epidemic. In active surveillance, public health officials needing the information contact the reporter at regular intervals and specifically ask about the occurrence of the disease(s) under surveillance. Thus, there is an active attempt by public health officials to obtain disease occurrence information from the reporter. The introduction of an active surveillance system may greatly increase the number of reported cases of a given disease and may even simulate an epidemic. The users of the surveillance data must be thoroughly informed of such changes in surveillance methods and an interpretation of the increase discussed in an editorial comment. While this system increases the sensitivity of reporting, it also increases the cost of surveillance due to the time needed to make active contact with the reporter.[32]

6.6. Sentinel Physician Reporting

A sampling system that can incorporate either active or passive surveillance is known as a sentinel reporting system. Depending on the size of the community, the degree of reporting desired, and the disease(s) under surveillance, the sentinel physicians may be a sample drawn from all practicing physicians or from among certain specialists who are more likely to see cases of the disease under surveillance. If a patient with the disease under surveillance may be seen by any physician, then the sample should be drawn from among all practicing physicians; however, if a childhood disease is under surveillance, then pediatricians and family practitioners would be the group from which the sample is drawn. The same sentinel physicians can be requested to report regularly, or alternating sentinel physicians can be selected to report weekly or monthly. If the reporting physicians were selected randomly, then the reported cases may be extrapolated to project the total number of cases of the disease that occurred in the area covered by the physicians, weighing each physician's reported cases according to the size of his or her practice. This will allow a fairly accurate estimate of the total cases to be made. However, if the sentinel physicians were not randomly selected or if they were volunteers, the total number of cases can only syndromic reporting be approximated from the number reported.

6.7. Laboratory Surveillance

Disease surveillance can also be maintained by regular monitoring of laboratory reports for the identification of etiologic organisms for diseases under surveillance. This system may be of secondary importance in that it serves to confirm a clinical diagnosis, or it may be of primary importance in identifying the etiology that was suspected by the clinician. For example, a case of pulmonary tuberculosis can be fairly accurately diagnosed on the basis of history and clinical evidence, including radiographs and a positive skin test. Identification of the organism in sputum confirms the diagnosis. Additionally, the antibiotic sensitivity of the organism can be determined that will confirm the proper treatment regime. However, with some diseases such as salmonellosis or syphilis, or shigellosis, accurate diagnosis is dependent on the laboratory identification of the etiologic agent. In diseases in which the laboratory plays a key role in identifying the etiologic agent, it is important to use the appropriate media necessary for this identification. For example, in maintaining surveillance for *Vibrio cholerae* in the United States, it is necessary to use special plating media such as thiosulfate-citrate-bile salt-sucrose (TCBS) agar if the organism is to be identified. Another example is the recognition of the importance of *Yersinia enterocolitica*. When 3 weeks of cold maintenance was required for culturing the organism, very few cases of diarrhea due to this organism were identified. With the introduction of a new culture medium (CIN) that eliminated cold storage, rapid identification became possible and cases are now being identified in routine laboratories. DNA/RNA probes and other microbiological molecular methods of diagnosis are becoming increasingly available and used.

Antibiotic-resistant microorganisms have become an increasing serious problem making it necessary for laboratories to perform antibiotic sensitivity testing as appropriate. These data must be reported to the health-care practitioners in the area in order for them to provide the proper therapy.

6.8. Hospital Surveillance

Surveillance can also be maintained by using hospital records (inpatient or outpatient) and hospital databases to detect either hospital-acquired or community-acquired infections. The records can be abstracted by specially trained enumerators or by record-room personnel (see Section 7.7 for further discussion of hospital surveillance, as well as Chapter 26).

6.9. Absenteeism Surveillance

Other methods of obtaining surveillance information depend on the specific disease. For diseases with high morbidity, an effective surveillance program can be developed by noting absenteeism from schools or industry, depending

on the ages of the involved population. All absenteeism during the period under surveillance may not reflect cases of the disease, so that further information may be needed, such as the rate of absenteeism due to other causes. Sickness benefit or insurance claims can also be utilized to develop surveillance data.

6.10. Syndromic Surveillance

Syndromic surveillance is the reporting of disease by the syndrome's signs and/or symptoms and not its etiologic diagnosis. This form of surveillance is commonly in place in developing countries in which physicians or academically trained health-care providers are not located in health clinics but there are health aides who can report. This form of surveillance can portray disease trends for purposes of control and prevention.

With the concern about bioterrorism, syndromic surveillance is being evaluated as an early warning system following the release of a biological agent.[32A,32B]

7. Special Surveillance

Special surveillance efforts can be established when the rate of occurrence of a disease increases either as part of the expected trend of that disease (periodic or seasonal increase) or as an unusual increase (epidemic). Special surveillance programs can also be developed in relation to the identification of a new disease entity; to provide disease data for research or investigation projects; to define the population among whom prevention measures should be instituted, such as vaccination; and also to evaluate control and prevention measures. Once the immediate need for a special surveillance system has been accomplished, the system should either be stopped or a regular surveillance program for that disease should be developed. In 1981, when the first cases of AIDS were reported, a special surveillance program was initiated. Once the national importance of surveillance data was identified, a regular surveillance program was established. All states now routinely report cases of AIDS to the CDC as part of the weekly surveillance program.

7.1. Influenza

Surveillance information concerning influenza is developed from the regular weekly reporting by 122 American cities of deaths from pneumonia and influenza. Reports of outbreaks of respiratory disease and reports of virus isolation from laboratories doing routine diagnostic work also provide surveillance data. To complement this system, at the beginning of the anticipated influenza season, additional surveillance activities are initiated to improve the knowledge concerning the occurrence of the disease.[33] Reports of absenteeism are solicited from selected industries and schools, since increased absenteeism may be one indication of increased influenza activity. Sentinel family practitioner volunteers from throughout the country report the percentage of patients they see in their practice with the clinical diagnosis of influenza. Virus laboratories are encouraged to process additional specimens from patients with symptoms of a respiratory disease, in order to increase the opportunity of isolating influenza viruses and subsequently to report the results to public health authorities. New rapid laboratory methods now facilitate recognition. These special surveillance activities are helpful in increasing the sensitivity of surveillance for influenza. With the advent of avian influenza in Asia, Africa, the middle east, and southern Europe, involving avians and humans, the intensity of surveillance has increased significantly. Countries are urged to report to the World Health Organization human and avian cases as soon as they are diagnosed and to make isolated influenza virus strains available to WHO for potential use in vaccine production. All such strains are being monitored for antigen drift or shift, which is important not only for vaccine formulation, but also to identify a new strain that may have greater ability for human to human transmission.

7.2. Gastroenteritis

During an epidemic of a gastrointestinal illness, such as salmonellosis, special surveillance efforts of a particularly high-risk group can be introduced to improve the information developed concerning the occurrence of the disease. This may include morbidity reporting, laboratory surveillance, case reporting, or field investigations. With these extra data may it be possible to recommend the most appropriate control and prevention measures. CDC initiated PulseNet in 1996 as an international network of public health laboratories that perform subtyping on bacteria that may be foodborne. Currently, the subtyping method is standardized pulse-field gel electrophoresis, with the results compared electronically with a database maintained by CDC. There are thousands of patterns from throughout the world on file. CDC also developed FoodNet in 1996 with the objectives of determining the burden and trends of foodborne illness in the United States. This surveillance program is able to relate illness to specific foods and to assess interventions. This program is a collaboration with the United States Department of Agriculture, the Food and Drug Administration, and 10 participating state health departments that include more than 650 clinical

laboratories. It receives reports of the isolation of nine enteric pathogens (see Chapter 6).

7.3. Guillain–Barré Syndrome

During the swine flu vaccination program (1976), the reported occurrence of Guillain–Barré syndrome among vaccinated persons resulted in the development of a separate, active, surveillance effort involving special reports from neurologists. Surveillance subsequently has failed to associate other influenza vaccines with this reaction.

7.4. Reye's Syndrome

To develop information concerning the possible association of Reye's syndrome with influenza, special surveillance activities and reporting forms were established for use by pediatricians and neurologists, who were more likely than other physicians to see patients with Reye's syndrome.[35]

7.5. Infant Botulism

When the first reports of infant botulism were published, it was apparent that a previously unrecognized public health problem needed defining. Accordingly, a special attempt at developing surveillance data was initiated by alerting public health officials as well as pathologists, pediatricians, and laboratories to the disease entity.[36] A special reporting form was developed so that pertinent information could be obtained on each case. These special efforts resulted in the reporting of additional cases and the accumulation of important epidemiological data that helped to improve our knowledge of the disease. Cases of this disease are now reported as part of the routine surveillance program in the United States.

7.6. Legionnaires' Disease

When this disease was first identified, there were many unsolicited reports of possible cases. In an effort to standardize these data to define the clinical entity better and to develop more useful epidemiological data, a special surveillance reporting form was developed and a specific definition of a case of Legionnaires' disease was publicized.[37] This resulted in important, new data being uncovered concerning this newly described disease entity. Cases of this disease continue to be reported as part of the routine national surveillance program.

7.7. Hospital Infections

Because of the increasing problem of hospital-acquired infections (nosocomial infections), special surveillance efforts have been developed within hospitals to accumulate data that might be useful for instituting procedures to control and prevent nosocomial infections.[38] The development of infection control committees with many responsibilities, one of which is to supervise a nosocomial infection surveillance program, has been of prime importance to these surveillance programs. Special personnel are usually dedicated to this activity. Surveillance data can be collected by various techniques including individual reports from physicians or floor nurses, ward rounds and record reviews by the infection control nurse, and regular review of the laboratory and pathology records. During ward rounds, the infection control nurse seeks clues to infection by asking physicians and nurses whether any of their patients have infections and noting which patients have elevated temperatures, are receiving antimicrobial agents, or are in isolation. The outpatient department and the employee health service can also be kept under surveillance, since infections noted in these areas may reflect infections among inpatients. All these sources of nosocomial infection surveillance data may not be incorporated into the routine surveillance program at the same time. Also, surveillance may be targeted at specific high-risk patients, areas, particularly, intensive care units, or procedures. As with general surveillance programs, the methods incorporated should reflect the specific needs of the program and available resources. Computer-based surveillance has been developed and may utilize hospital databases such as the admission, transfer, and discharge database to track patient movement, the laboratory database to identify particular infections or antibiotic resistance, and the pharmacy database to identify patients receiving antimicrobics. Community-acquired infections may also be brought under surveillance as an addition to the hospital infection surveillance program. The surveillance and recognition of hospital infections are dealt with in greater detail in Chapter 26.

7.8. Arbovirus Diseases

CDC has developed a special surveillance program for arbovirus diseases, called ArboNet, an Internet-based surveillance system managed by state health departments and CDC. This system has been valuable in tracking the spread of West Nile virus infection and diseases from the northeastern United States in 1999 to all contiguous states by 2005.

7.9. High-Risk Population

A special surveillance program can be developed to identify specific disease among high-risk populations who will derive the greatest benefit from a particular prevention measure. For example, this has been useful for both meningococcal and pneumococcal disease for which specific, effective vaccines have been developed and are now recommended for use among specific highly susceptible populations that were defined from analysis of surveillance data. The administration of influenza and pneumococcal vaccine to particular groups has been mandated by the Centers for Medicare and Medicaid (CMS) and computer-based programs have been introduced to vaccinate target groups and prevent lost opportunities for prevention.

7.10. Emerging Infections

The recognition of AIDS in the United States in 1981 raised the question of whether our surveillance systems were adequate to recognize new diseases caused by agents such as Lassa, Ebola, and Marburg viruses, as well as other older agents that were mutating, such as influenza, or the occurrence of antibiotic resistance to common infectious agents such as the pneumococcus, tubercle bacillus, and enterococci. This led to a National Institutes of Health (NIH) conference in May 1989 that dealt with emerging viral infections, their development, surveillance issues, and means of recognition, which has been subsequently published in a book edited by Morese.[39] In June 1991, the Institute of Medicine (IOM) of the National Academy of Sciences convened a 19-member committee to review the broader field of all emerging infections. This report was published in 1992 and discussed six factors that the committee felt could account for the occurrence of emerging and reemerging infections.[40] Their report also discussed some actions including surveillance that could help control these problems. Another IOM committee was named in 2003 to bring these discussions up to date. They extended the list of factors to 13 and stressed the need for new novel surveillance systems to better define the problems.[40A]

The CDC was quick to recognize the need for additional methods for surveillance and control of these infections.[41] The CDC has developed Centers for Excellence for Public Health Information at five universities, part of whose mandate is to develop novel systems of surveillance and to incorporate electronics into surveillance systems. The role of the United States in emerging infections has been defined by Henderson.[42]

7.11. Serosurveillance

The use of serological testing on a regular basis may provide disease occurrence information not available by other less costly methods. A reproducible serological test and a responsive, approved laboratory are necessary ingredients for this activity. Serology may be useful in adding information to regular surveillance methods and reflects clinical and subclinical infections. Another example of the use of serology is seen in communities in which there is an interest in determining the incidence of human immunodeficiency virus (HIV) infections among pregnant women for which a serosurveillance program is developed in order to provide the necessary data. Serosurveillance has also been used to track the movement of West Nile virus activity across the country.

Other special surveillance techniques can be incorporated to handle specific problems. For example, if there is concern regarding foodborne diseases, then in addition to the routine reporting of cases and epidemics, surveillance of potentially contaminated foods can be instituted by utilizing laboratory culturing of foods routinely supplied by commercial sources. The importation of food items from abroad and their nationwide distribution has resulted in interlinked geographically distant epidemics of the same infection. This requires closely collaborative surveillance activities in state health departments working through the CDC and with the Federal Department of Agriculture (FDA). Surveillance of human carriers of certain pathogenic organisms such as staphylococci or salmonella can be initiated if there is concern about the occurrence of disease transmitted by asymptomatic carriers.

8. Data Analysis

Once the data have been collected, they must be collated and analyzed at regular intervals. The analysis can be simple or complex depending on the needs of the surveillance program, time constraints, how the data are to be used, and the personnel and facilities available. In addition to analyzing data in the routine manner (cases per 100 population), other methods of quantitating disease occurrence data are being utilized for some diseases. These methods provide a more realistic appraisal of the impact of the disease's occurrence upon a population. Some of these methods include calculating years of potential life lost (such as in evaluating injuries), number of cases of a disease per exposure day (such as ventilator-dependant pneumonia per ventilator days), and number of cases of a disease per procedure performed (bacteremias per cardiac catheterization). As surveillance becomes more complex and as more data are

handled, computerization of the data may be desirable and necessary. As previously stated, surveillance data can be entered directly into the computer by the reporting office instead of being handled by one or more intermediate individuals. There are software programs available that can analyze the surveillance data and prepare figures summarizing these analyses. One such software program is Epi Info which is used by the CDC to handle the data reported through the country's disease surveillance program, including preparing the data for publication in the MMWR.

Data analysis will usually suggest the best point for intervention. Occasionally, additional data may need to be gathered by additional surveillance activities or by special investigations.

8.1. Frequency of Review

The frequency, type, and complexity of the analyses are dependent on the use of the summary data. A routine surveillance program may require analyses at monthly or weekly intervals; in epidemic circumstances, it may be necessary to review the surveillance data at more frequent intervals, such as weekly or even daily. The data should be analyzed according to the three key epidemiologic variables, time, place, and person.

8.2. Time

When characterizing the data by time, there are four trends to consider. The first is the *secular* trend, which refers to the occurrence of the disease over a prolonged period of time, such as years. The secular trend of tetanus is one of gradually decreasing incidence (Figure 1). The decreasing secular trend of an infectious disease can be the result of the interaction of various factors such as socioeconomic educational, nutritional, and specific and nonspecific immunity factors within the involved population.

The *periodic* trend,which is the second time trend to consider, refers to the temporary variations from the

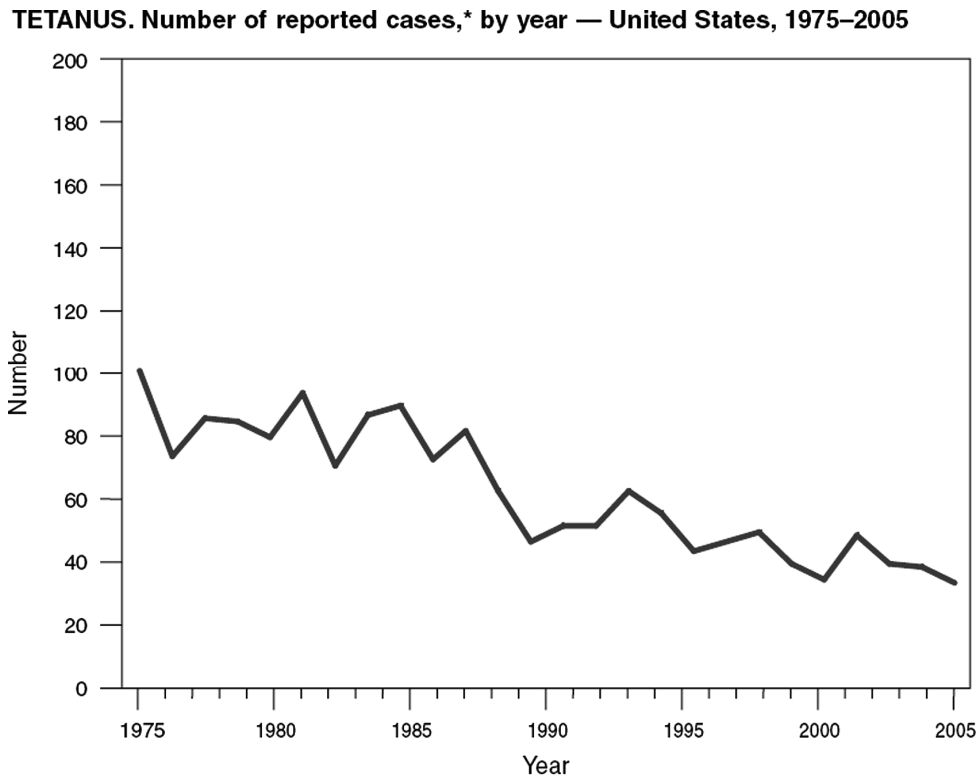

Figure 1. Tetanus: reported cases, United States, 1975–2008.

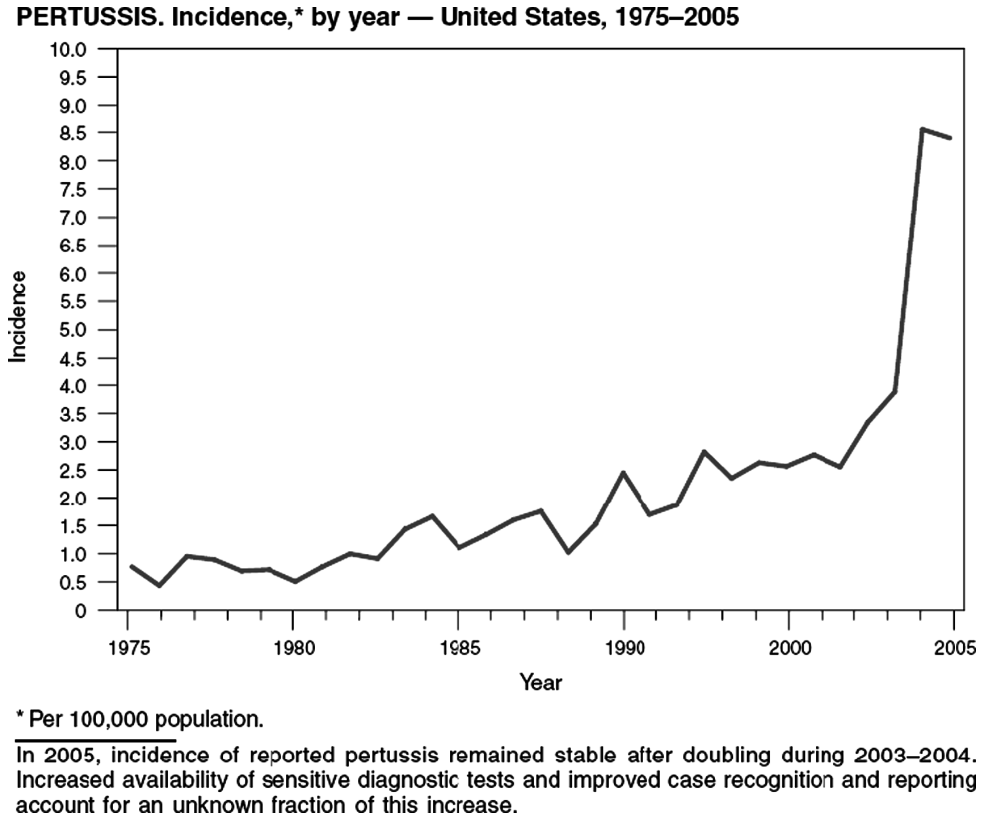

Figure 2. Pertussis: reported incidence rates per 100,000 population, United States, 1975–2008.

secular trend. For example, in considering pertussis, periodic increases in incidence approximately every 5 years can be seen on the background of the overall secular trend of decreasing incidence of the disease (Figure 2). The periodic trends represent variations in the level of immunity (herd immunity) to the etiologic agent influenced by natural infection, variation in the immunity levels of the population reflecting immunization, births, or migrating, or by changes in the antigenic composition of the agent.

The third trend is that of the *annual* variation, which frequently represents seasonal patterns. For example, foodborne diseases are associated with seasonal increases in the late summer and fall that may represent the influence of the ambient temperature on the ability of organisms to multiply in or on their reservoirs and sources, resulting in an increased concentration of organisms for potential contact with susceptible hosts. Additionally, the frequency of picnics and the lack of refrigeration add to the increased opportunity for small doses of agents to multiply to infectious doses.

The fourth time trend is that of the *epidemic* occurrence of the disease. If not noted earlier, an epidemic may be discovered by analyzing surveillance data. This has been seen when cases related to a common source are scattered over several health jurisdictions. For example, a *Salmonella*-contaminated food may result in the occurrence of cases over the distribution route of the food; the individual cases may not serve to alert any one health jurisdiction, but the collection of multiple cases may be distinct enough to be identified as an epidemic. Thus, surveillance can serve as an early warning system for epidemics.

When surveillance data are analyzed for time trends, it is necessary to compare these data with data collected over past years, to accurately interpret the current pattern of the occurrence of disease. Otherwise, changes in the occurrence of the disease may not be definable as being either normal or unusual variations.

8.3. Place

When analyzing surveillance data by place, it is important to recognize that the place represented by surveillance data may represent the area where the patient lives and not the area where the patient became infected. For epidemiological purposes, the important place(s) is where contact

occurred between the patient and the infectious agent or the place where the source of infection became infected. The place of interest will be determined by whether there is interest in control of the current occurrence of the disease or in prevention of future cases. Control measures directed at the site where the host came into contact with the agent can lead to control of additional similar cases immediately related to the initial case, but may not prevent additional cases if there are other sources of the organism that susceptible individuals may have contact with. For example, if a food is contaminated with *Salmonella* in the factory where it is prepared and the exposure of the host occurs in a restaurant serving that food, then closing the restaurant will not prevent cases from occurring in association with another restaurant that also obtained contaminated food from the same factory. Prevention of future cases can be accomplished by eliminating the source of contamination, in this instance, at the food-processing plant.

8.4. Person

Person factors to be defined in analyzing surveillance data may include age, sex, nationality, level of immunity, nutrition, lifestyle (such as sexual practices and intravenous drug use), socioeconomic status, genetic factors, travel history, hobbies, personal habits, and occupation. The evaluation of these factors, frequently referred to as risk factors, is important in further describing the occurrence of disease. For example, age-specific attack rates can be important in determining where control and prevention measures should be directed. Occupation may give a clue as to where intervention measures need to be directed. For example, in evaluating cases of brucellosis, knowing that abattoir personnel who work on the kill floors are at a higher risk of developing disease than personnel in other areas of the plant indicates where control measures need to be directed. In maintaining surveillance of avian influenza, it is important to determine if the patient had contact with avians or could it be the result of person to person transmission.

9. Reports

Appropriate reports should be prepared and distributed to those individuals who participate in the surveillance program as well as those who have a responsibility for preventive action. The purpose of the surveillance report is to communicate with people, to disseminate information, to educate the reader, and to direct, stimulate, and motivate the persons responsible for action. Reports can also be useful in acknowledging contributors to the surveillance activity. The report should not only summarize the surveillance data but also provide an interpretation of the analyses. Control and prevention measures can be discussed. Surveillance reports can also serve to alert the reader to impending problems, newer methods of control and prevention, current investigations, and new information developed from research or field investigations. They can also serve to stimulate better reporting by health-care practitioners.

Reports are usually prepared at regular intervals, such as weekly, monthly, quarterly, or annually. The frequency should reflect the interest in the data as well as the need for distribution of the data as related to control and prevention actions. During an epidemic, the immediate dissemination of data may be critical to stimulating reporting and to the institution of appropriate control measures; thus, daily or weekly reports may be indicated. It may be appropriate to distribute foodborne disease surveillance reports at weekly or monthly intervals during the summer and fall months due to the increased incidence of disease at these periods and then to reduce the frequency of reports during the remainder of the year. Special reports can be distributed as necessary; if rapid dissemination of the information is important, it can be distributed by express mail, telegram, telephone, fax, or computer. Rapid dissemination of information over a wide area may be of such critical importance that use of the public news media should be considered.

In the United States, almost all state health departments prepare and distribute at weekly or monthly intervals comprehensive surveillance reports that summarize their disease surveillance data. The national surveillance data are summarized by the CDC at varying intervals depending on the disease and its frequency. Those diseases reported weekly are summarized in the *MMWR*; other diseases are summarized in specialty surveillance reports that are distributed at regular intervals, from monthly to annually. An annual summary is prepared that summarizes in tables and figures all of the disease occurrence data reported by the states during the previous year and compares these data with data reported during the previous years. Characteristic of many of the CDC surveillance reports and especially of the MMWR is the interpretation of surveillance data and editorial comments that are integral parts of the reports. These reports are available to anyone who would like to receive them. The MMWR is now available by computer through the CDC's World Wide Web server at http://www.cdc.gov/mmwr. A hard copy of all of the CDC surveillance reports can be obtained from the Massachusetts Medical Society or the US Government Printing Office. World surveillance data are collected, summarized, and distributed by the WHO in a weekly and other reports.

10. Evaluation

Once a surveillance program has been developed and has been in operation for several years, it should be reviewed and evaluated. Even though the program is operational, it should not be assumed that it is effectively meeting the objectives of the surveillance activity. Thacker and Berkelman discuss evaluation[2] and the CDC has developed a guide for the evaluation of public health surveillance systems.[7]

11. Limitations of Surveillance

Surveillance of disease is dependent on a series of events that if not followed may prevent the case from being reported. The events include that the disease be severe enough that medical attention is sought and if sought, must be available; laboratory diagnostic facilities may be necessary and should be available; the health-care provider or his or her representative must report the case; and the respective health department must have adequate resources and direction to support the surveillance program. There needs to be consistency in the case definition, in the collection of data, and in the mechanism of reporting. Any alterations in these events may change the apparent pattern of disease. The consistency and stability of the occurrence of these events are vital to the development of reliable surveillance data. In addition to recognition of clinical cases, there may be many infected persons with mild or subclinical illnesses that are not noted in the routine surveillance system. For these cases to be noted, laboratory studies of the distribution of the organism or the antibody to it are required.

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13. Suggested Reading

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