# Lesson 6 Investigating an Outbreak

One of the most exciting and challenging tasks facing an epidemiologist working in a public health department is investigating an outbreak. Frequently, the cause and source of the outbreak are unknown. Sometimes large numbers of people are affected. Often, the people in the community are concerned because they fear more people, including themselves, may be stricken unless the cause is found soon. There may be hostilities and defensiveness if an individual, product, or company has been accused of being the cause. Into this pressure-packed situation comes the epidemiologist, sometimes from the local health department, more often from "the outside." In this setting the epidemiologist must remain calm, professional, and scientifically objective. Fortunately, epidemiology provides the scientific basis, the systematic approach, and the population and prevention orientations that are needed.

## **Objectives**

After studying this lesson and answering the questions in the exercises, a student will be able to do the following:

- List the reasons that health agencies investigate reported outbreaks
- List the steps in the investigation of an outbreak
- Define the terms cluster, outbreak, epidemic
- Given the initial information of a possible disease outbreak, describe how to determine whether an epidemic exists
- State what a line listing is and what it is used for
- Given information about a community outbreak of disease, execute the initial steps of an investigation and develop biologically plausible hypotheses
- Draw a traditional epidemic curve
- Given data in a two-by-two table, calculate the appropriate measure of association and chi-square test

# Introduction to Investigating an Outbreak

### Uncovering Outbreaks

One of the uses of surveillance--covered in Lesson 5--is the detection of outbreaks. Outbreaks may be detected when routine, timely analysis of surveillance data reveals an increase in reported cases or an unusual clustering of cases. In a health department, we may detect increases in or unusual patterns of disease from the weekly tabulations of case reports by time and place or from the examination of the exposure information on the case reports themselves. For example, health department staff detected an outbreak of hepatitis B that was transmitted by a dentist because they regularly reviewed and compared the dental exposures reported for hepatitis B cases (19). Similarly, in a hospital, weekly analysis of microbiologic isolates from patients by organism and ward may reveal an increased number of apparent nosocomial (hospital-acquired) infections in one part of the hospital.

Nonetheless, most outbreaks come to the attention of health authorities because an alert clinician is concerned enough to call the health department. The nationwide epidemic of eosinophilia-myalgia syndrome (EMS) was first detected when a physician in New Mexico called a consultant in Minnesota and realized that, together, they had seen three patients with a highly unusual clinical presentation. All three patients said they used L-tryptophan. The local physician promptly called the New Mexico State Health and Environment Department, which set into motion a chain of public health actions leading to the recall of L-tryptophan throughout the country (14,23).

Members of affected groups are another important reporting source for apparent clusters of both infectious and noninfectious disease. For example, someone may call a health department and report that he and several co-workers came down with severe gastroenteritis after attending a banquet several nights earlier. Similarly, a local citizen may call about several cases of cancer diagnosed among his neighbors and express concern that these are more than coincidental. Most health departments have routine procedures for handling calls from the public regarding potential communicable disease outbreaks, and a few states have developed guidelines for how to respond to noninfectious disease cluster reports (2,8,9).

## Why Investigate Possible Outbreaks

Health departments investigate suspected outbreaks for a variety of reasons. These include the need to institute control and prevention measures; the opportunity for research and training; program considerations; and public relations, political concerns, and legal obligations.

### **Control/prevention**

The primary public health reason to investigate an outbreak is to control and prevent further disease. Before we can develop control strategies for an outbreak, however, we must identify where the outbreak is in its natural course: Are cases occurring in increasing numbers or is the outbreak just about over? Our goal will be different depending on the answers to these questions.

If cases are continuing to occur in an outbreak, our goal may be to prevent additional cases. Therefore, the objective of our investigation would be to assess the extent of the outbreak and the size and characteristics of the population at risk in order to design and implement appropriate control measures.

On the other hand, if an outbreak appears to be almost over, our goal may be to prevent outbreaks in the future. In that case, the objective of our investigation is more likely to be to identify factors which contributed to the outbreak in order to design and implement measures that would prevent similar outbreaks in the future.

The balance between control measures versus further investigation depends on how much is known about the cause, the source, and the mode of transmission of the agent (11). Table 6.1 illustrates the relative emphasis as influenced by how much we know about these factors.

# Table 6.1Relative priority of investigative and control efforts during an outbreak,<br/>based on level of knowledge of the source, mode of transmission,<br/>and causative agent

		Known	Unknown
Causative Agent	Known	Investigation + Control +++	Investigation +++ Control +
	Unknown	Investigation +++ Control +++	Investigation +++ Control +
		+++ = highest priority	

Source/Mode of Transmission

+++ = highest priority + = lower priority Source: 11

If we know little about the source and mode of transmission, as indicated in the right-hand column of the table, we must investigate further before we can design appropriate control measures. In contrast, if we know the source and mode of transmission, as indicated in the left-hand column, control measures can be implemented immediately. However, if we don't know what the agent is, as indicated in the bottom row of the table, we must investigate further to identify the agent.

The public health response to the outbreak of EMS described earlier illustrates this point. Since investigators quickly determined that EMS was associated with the ingestion of L-tryptophan, that product was immediately withdrawn from the market, and persons were warned to avoid taking any they had on hand. However, officials continued the investigation for quite some time until they were certain they had identified the specific contaminant and reason that contamination occurred.

The decisions regarding whether and how extensively to investigate an outbreak are influenced by characteristics of the problem itself: the severity of the illness, the source or mode of transmission, and the availability of prevention and control measures. It is particularly urgent to investigate an outbreak when the disease is severe (serious illness with high risk of hospitalization, complications, or death) and has the potential to affect others unless prompt control measures are taken. For example, in the United States, every case of plague and botulism is investigated immediately to identify and eradicate the source. Cases of syphilis, tuberculosis, and measles are investigated promptly to identify contacts and interrupt further transmission.

### **Research opportunities**

Another important objective of outbreak investigations is, simply, to gain additional knowledge. Each outbreak may be viewed as an experiment of nature waiting to be analyzed and exploited. Each presents a unique opportunity to study the natural history of the disease in question. For a newly recognized disease, field investigation provides an opportunity to define the natural history--including agent, mode of transmission, and incubation period--and the clinical spectrum of disease. Investigators also attempt to characterize the populations at greatest risk and to identify specific risk factors. Acquiring such information was an important motivation for investigators studying such newly recognized diseases as Legionnaires' disease in Philadelphia in 1976, toxic shock syndrome in 1980, acquired immunodeficiency syndrome in the early 1980's, and EMS in 1989.

Even for diseases that are well characterized, an outbreak may provide opportunities to gain additional knowledge by assessing the impact of control measures and the usefulness of new epidemiology and laboratory techniques. For example, an outbreak of measles in a highly immunized community provides a setting for investigators to study vaccine efficacy, the effect of age at vaccination, and the duration of vaccine-induced protection (16). An outbreak of giardiasis was used to study the appropriateness of a new clinical case definition (15), while an outbreak of pertussis was used to study the performance of a new culture medium (7).

### Training

Investigating an outbreak requires a combination of diplomacy, logical thinking, problem-solving ability, quantitative skills, epidemiologic know-how, and judgment. These skills improve with practice and experience. Thus many investigative teams pair a seasoned epidemiologist with an epidemiologist-in-training. The latter gains valuable on-the-job training and experience while providing assistance in the investigation and control of the outbreak.

## Public, political, or legal concerns

Public, political, or legal concerns sometimes override scientific concerns in the decision to conduct an investigation. Increasingly, the public has taken an interest in disease clusters and potential environmental exposures, and has called upon health departments to investigate. Such investigations almost never identify a causal link between exposure and disease (4,22). Nevertheless, many health departments have learned that it is essential to be "responsibly responsive" to public concerns, even if the concern has little scientific basis (9,2,18). Thus several states, recognizing their need to be responsive and an opportunity to educate the public, have adopted protocols for investigating disease clusters reported by its citizens. Some investigations are conducted because the law requires an agency to do so. For example, CDC's National Institute of Occupational Safety and Health (NIOSH) is required to evaluate the risks to health and safety in a workplace if requested to do so by three or more workers.

#### **Program considerations**

Many health departments routinely offer a variety of programs to control and prevent illnesses such as tuberculosis, vaccine-preventable diseases, and sexually transmitted diseases. An outbreak of a disease targeted by a public health program may reveal a weakness in that program and an opportunity to change or strengthen the program's efforts. Investigating the causes of an outbreak may identify populations which have been overlooked, failures in the intervention strategy, changes in the agent, or events beyond the scope of the program. By using an outbreak to evaluate the program's effectiveness, program directors can improve the program's future directions and strategies.

# Exercise 6.1

During the previous year, nine residents of a community died from the same type of cancer. List some reasons that might justify an investigation.

Answers on page 398.